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ABSTRACT

An evaluation and research program was designed to determine user satisfaction and the practicality, reliability, and maintainability of the Digicassette (or Portable Braille Recorder--PBR) and to study the braille reading and writing functions. Ten PBRs were placed with 14 students and 14 adults. Products of the research program included training manuals, journal articles, and quarterly reports. Multiple baseline and other research designs were employed to obtain data on braille writing using measures having demonstrated validity and reliability. Data were also obtained from teacher observations, interviews, and user self report devices. A program of formative and summative evaluation was provided for continuous assessment and final appraisal for the evaluation and research program. All students readily accepted the Digicassette and quickly learned to use it. For the most part, students used the Digicassette for notetaking in classes, since reading materials in cassette braille form are limited. A minimum of maintenance problems occurred throughout the study, due in part to the detailed instructions in troubleshooting equipment problems that the students received prior to data collection activities. However, inconsistencies in the battery life of the 12 cell Digicassette demanded the frequent use of an external power supply. The oral reading and reading error rates and the writing error rates of eight blind students in Ohio and 16 blind students in Tennessee were evaluated. It was found that all Ss read with the Digicassette at about 50% of their oral reading rate with equivalent paper braille. However, reading accuracy as measured by the number of reading errors committed did not differ between the two reading conditions. Mechanical constraints of the Digicassette, such as the 12 cell reading line, the lack of hyphenation, and the inability to reread the text one line at a time, are hypothesized to be major factors in the slower reading rates with the Digicassette. Writing rates and writing error rates were virtually identical to writing rates using the Perkins braille for all students. In summary, the Digicassette was demonstrated to be a viable addition to the standard methods of braille reading and writing. (Author/SB)

Volume I
Final Report

Project No. BEH-AH-70171

Evaluation and Research Program for the
Portable Braille Recorder (PBR)

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ABSTRACT

EVALUATION AND RESEARCH PROGRAM FOR THE PORTABLE BRAILLE RECORDER (PBR)

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October, 1979

A new electronic braille reading and writing machine has become available to help solve some of the persisting problems of persons who are blind. An evaluation and research program is needed to determine the usefulness of the newly developed equipment becoming available from the Franch firm Electronique Linguistique Informatique Appliquees (ELINFA).

The PBR, measuring 8 x 9 x 2 inches and weighing four pounds, is a fast and silent braille writing and reading machine which also includes an audio tape recorder and the capability for calculating in braille when connected through an interface to commonly available pocket or desk calculators. A standard 90-minute audio tape cassette can contain three hundred thousand (300,000) braille characters, the equivalent of several braille volumes, the print equivalent of two hundred and twenty (220) page paperback books. The PBR can serve as a braille computer terminal. A family of interrelated instruments is to be developed using the PBR and thus opening additional employment opportunities for blind persons.

Braille, typed on a seven-key keyboard is reproduced on a twelve character reading display. A new set of 12 characters is displayed each time a control switch is pressed. Thus, the reader controls his/her own rate without lengthy return sweeps to the beginning of the next line and without moving from line-to-line, turning pages, or changing volumes. A counter with braille readout provides approximate indexing corresponding to the print or conventional braille counterpart.

The evaluation and research program for the Portable Braille Recorder was intended to determine user satisfaction and the practicality, reliability, and maintainability of the equipment and to study the braille reading and writing functions. Ten PBRs were placed in educational settings in Columbus, Ohio and Nashville, Tennessee to serve elementary and secondary braille reading students in local day and residential school programs. Products of the research program include training manuals, journal articles, and quarterly reports. Multiple baseline and other research designs were employed to obtain data on braille writing using measures having demonstrated validity and reliability. Data were also obtained from teacher observations, interviews, and user self-report devices. A program of formative and summative evaluation was provided for continuous assessment and final appraisal for the evaluation and research program.

Results

All students readily accepted the Digicassette and quickly learned to use it. For the most part, students used the Digicassette for notetaking in classes, since reading materials in cassette braille form are limited. A minimum of maintenance problems occurred throughout the study, due in part to the detailed instructions in troubleshooting equipment problems that the students received prior to data collection activities. However, inconsistencies in the battery life of the 12-cell Digicassette demanded the frequent use of an external power supply.

The oral reading and reading error rates and the writing error rates of eight blind students in Ohio and sixteen blind students in Tennessee were evaluated. It was found that all subjects read with the Digicassette at about 50% of their oral reading rate with equivalent paper braille. However, reading accuracy as measured by the number of reading errors committed did not differ between the two reading conditions. Mechanical constraints of the Digicassette, such as the 12-cell reading line, the lack of hyphenation and the inability to reread the text one line at a time, are hypothesized to be major factors in the slower reading rates with the Digicassette.

Writing rates and writing error rates were virtually identical to writing rates using the Perkins brailier for all students.

In summary, the Digicassette was demonstrated to be a viable addition to the standard methods of braille reading and writing.

EXECUTIVE SUMMARY

The Evaluation and Research Program for the Portable Braille Recorder was originally conceived as a three-year research program to determine user satisfaction and practicality, reliability and maintainability, of the equipment and to study the braille reading and writing functions. Ten portable braille recorders were to be placed in educational settings in Columbus, Ohio and Nashville, Tennessee to serve elementary and secondary braille reading students in local day and residential school programs.

The two years of research sponsored by the Division of Media Services of the Bureau of Education for the Handicapped through its field initiated research authority enabled us to evaluate the portable braille recorder and to develop training manuals, journal articles, and related products. Data were obtained on braille reading and writing performance using measures having demonstrated validity and reliability. Data also were obtained from teacher observations, interviews, and user's self-report devices.

The findings revealed that child and adult users were found to adapt readily to reading with the portable braille recorder. However, there were significant differences in rates of oral reading with the PBR and conventional braille materials. Under test conditions, subjects (both child and adult, and both good and poor braille readers) read approximately 50% fewer words per minute with the portable braille recorder than with conventional braille materials. There were no significant differences, however, in oral reading error rates using conventional or cassette braille materials.

Experience with the portable braille recorder did not appear to affect conventional braille reading ability either adversely or favorably. Subjects were found to adapt their reading style to the unique features of the 12-cell reading display; they generally read the display using their right index finger only in a "circular" or "rotating" fashion, sweeping across the 12-cell display and over the touch control and back to the beginning of the display. Subjects readily accepted the differences in writing using the PBR and generally were enthusiastic about the "light touch" of the PBR as compared with the heavier touch necessary with the Perkins Brailler, their usual mode of writing.

Adult subjects were found to adapt quickly to writing with the PBR. No statistically significant differences in writing rate or writing error rate were demonstrated in assessments of writing using the PBR and the Perkins Brailler.

Generally, the PBR was found to be more appealing to college students than to either high school students, to elementary school children, or to blind adults because of its use as a notetaking device. Most participants in the research program preferred to continue to read conventional braille volumes, although it must be understood that they expressed this preference with the knowledge that portable braille recorder materials are not yet generally available.

In general, participants were more satisfied with the PBR than they were dissatisfied; they liked using it for notetaking in classes, they enjoyed the quietness, small size, light weight, portability and the correcting features of the machine. The 12-cell reading display, the touch control switch and the gravity control feature were agreed to be disadvantages of the PBR.

The PBR was found to be reliably maintainable with careful use. Battery related malfunctions (frequently due to over-charging or under-charging) accounted for most of the equipment failures; broken pins necessitated repairs requiring return to the ELINFA office in Washington.

Service and repair time at the supplier's Washington office was often lengthy (4-6 weeks), and transportation by Federal Express (required by the supplier) was expensive.

Computer generated braille cassettes were produced by using APH computer tapes; however, standard duplicating equipment did not make useable copies of the master tapes.

The Evaluation and Research Program for the Portable Braille Recorder was successfully completed during 1977-1979. The impending availability of the 20-cell display and the new Versabraille equipment will enable further evaluation of such paperless braille equipment. Further research with this equipment should be undertaken as soon as possible.

INTRODUCTION

Electronic braille reading and writing machines are among the most significant contributions to the education of the blind since the advent of the Perkins brailler. Such electronic equipment makes it increasingly possible for visually impaired persons to work and to learn side-by-side with their sighted peers. The Portable Braille Recorder is a complete electronic braille reading and writing machine and an audio tape recorder developed by the ELINFA Company of France. It measures only 8 X 9 X 2 inches and weights just four pounds.

For the first time since the invention of braille, an electronic braille writer and reading device can be made available to every blind person. Braille typed on a seven-key keyboard is reproduced on a 12-character reading display. A new set of 12 characters is displayed each time a control switch is touched, enabling the reader to control his or her own rate of reading without lengthy return sweeps to the beginning of the next line and without moving from line-to-line, turning pages, or changing volumes. A tape revolution counter with braille number readout provides a means of locating information in addition to conventional braille page numbers which can be included with the braille textual material. The braille and audio signals are recorded electronically on standard audio cassette tapes. A standard 90-minute audio tape cassette can hold 300,000 braille characters which is the equivalent of several braille volumes or the approximate equivalent of a 220 page paperback book.

The Portable Braille Recorder (here in after called the PBR) has the capability to be used as a braille calculator when connected through an interface to commonly available pocket or desk calculators. PBR can also function as a braille computer terminal by providing digitized input and output in braille form which enables the blind individual to function more independently with a wide array of computers. Undoubtedly the PBR will facilitate new vocational and employment opportunities for braille reading individuals. Early introduction of the PBR into educational programs should encourage the development of new and different career and vocational opportunities for school children and youth who are blind.

Developing communication skills is among the most significant and difficult problems in the special education of children who are unable to read print because of visual impairment. Reading, writing, and calculating in braille and listening to recorded materials reduce, but do not eliminate, the handicap of visual loss. Braille reading materials and writing equipment are bulky and cumbersome. Calculators rarely provide braille readout. The PBR, therefore, has the potential to make significant changes in the education of persons who are visually handicapped. As Lowenfeld (1973) has said, "one of the pre-conditions to make any education of blind children comparable to that of the seeing (is - a workable system of reading and writing)". The PBR also has the promise of increasing the scope and amount of materials available to braille readers. When the equivalent of several braille volumes can be made available on a single audio tape cassette, dramatic savings can be made in time, in preparation expense, materials, storage costs, mailing, and dissemination cost and in other aspects of production and distribution of braille reading materials.

Currently, the PBR is expensive, but if it can be demonstrated by evaluation and research to be effective and to have multiple applications, it should be useable by a large variety of individuals who are blind. With an enlarged market, production of the equipment can be increased, and its price could be reduced. Explorations of the advantages and disadvantages of the numerous possible educational and vocational applications of the equipment will facilitate its rapid assimilation by children and adults who are blind, especially if the appropriate and necessary software and applications have been identified and studied so that the use of the equipment will not be hampered by a lack of materials or guidelines for effective use.

The demonstration of this new possibility for the special education and prevocational development of children with visual handicaps can contribute substantially to the adjustment, education, and occupational placement of visually handicapped persons through technology and related instructional materials and media. The use of the PBR will also facilitate the preparation of professional and allied personnel such as braillists, who are engaged (or are preparing to engage) in special education or related programs. Numerous applications of the equipment in both pre-service preparation and continuing education can be envisioned. For example, the PBR can facilitate meeting a criterion listed by Taylor (1973) for "making sure that each student is academically and socially prepared and has at least: . . . basic textbooks for each subject available to him in a reading medium he can handle efficiently at the time he needs them, all the equipment and special educational materials he needs for the study of his various subjects at home with duplicates of heavy or bulky articles to keep at school."

This report will present the results of the evaluation and research program for the PBR with braille reading elementary, secondary, and college-aged students in the Columbus, Ohio schools, the Nashville, Tennessee Metropolitan schools, and George Peabody College for Teachers, Nashville, Tennessee. This evaluation and research program was designed to evaluate user satisfaction, the practicality, reliability, and maintainability of the equipment, and the facilitation and promotion of educational achievement in reading and writing through the use of the PBR or Digicassette.

Review of Literature

The literature relevant to this investigation is limited because the PBR first became available in 1977. However, material on reading, reading and writing in braille, and research methodology do have relevance, and this research has been identified, reviewed, and has been used as a guide to the planning and implementation of this project.

Burklen (1917) reported studies of braille specifications and reading mechanics. He brought together extant information on touch reading of the blind that has influenced instruction in braille reading and writing until the present. In his book, translated and edited by Merry (1932), he reported some of the earliest controlled studies of touch movements, size and space factors, pressure, reading speed, and braille code characteristics. He also identified some of the characteristics of good and poor braille readers.

Maxfield (1928), in her book, "The Blind Child and His Reading", included guidelines for teachers of braille reading. These guidelines were used in developing a checklist for use in connection with evaluation of reading on the PBR.

Since 1953, the American Printing House for the Blind has carried on a program of research on reading in braille through the Department of Educational Research. Ashcroft (1960) studied Errors in Oral Reading of Braille at Elementary Grade Levels. He devised the Oral Braille Reading Mastery Test, identified the most frequently appearing errors and observed braille reading behavior of large numbers of elementary readers. His review of the literature identified research and publications relevant to the present evaluation and research program.

Nolan and Kedaris (1969) reported on nine systematically planned studies in a monograph entitled, "Perceptual Factors in Braille Word Recognition." These studies are the most carefully designed and controlled experimentation and the most definitive work ever undertaken in matters related to braille reading. This research provided many guidelines used in the design and implementation of the present study.

Lowenfeld, Abel, and Hatlen (1969) surveyed braille reading and the methods used in its teaching. The instrumentation and data on reading behavior, comprehension, and reading rates provided guidance for planning the evaluation of the PBR.

The catalog of projects funded by the Bureau of Education for the Handicapped entitled "Twelve Years of Research on Education for the Handicapped (Contract Research Corporation, 1976) reports several relevant braille technology projects. Most significant is the "Argonne Project."

Since 1968 when the Argonne project was first funded, Arnold Gruwold has been developing "A System for Compact Storage of Information on Magnetic Tape Readable by Touch as Braille Characters by Means of a Portable Reading Machine." Recent reports (Personal Communication, BEH 7/5/77) indicated that production of this machine was still 1.5 to 2 years away and that reliability studies on prototype machines were not yet complete. The Argonne machine provides only the reading function, using a moving belt of braille activated by reel-to-reel audio tape.

A search of the NIMIS (National Instructional Materials Information System) produced 36 abstracts on writing and duplicating equipment. No

braille reading machine was identified but included were the available conventional braille writers; Perkins, Lavender, Stainsby, Marburg and the AFB Telatouch along with the Triformation Embossers and the CalcuTac calculators. The search identified nothing comparable to the PBR.

Despite the lack of literature concerning electronic braille equipment, this study was undertaken with the purpose of evaluating the PBR on many dimensions, including user satisfaction, the reliability, practicality, and maintainability of the PBR, braille reading and writing performance with the PBR, and patterns of PBR use. Year I of this study (October, 1977 - September, 1978) was conducted at Ohio State University under the direction of S. C. Ashcroft, professor of Special Education. In September, 1978, S. C. Ashcroft accepted a faculty position in the Department of Special Education at George Peabody College for Teachers, Nashville, Tennessee. Therefore, this evaluation project was moved to Nashville, Tennessee, for Year II (Oct. 1978 - Sept. 1979).

Purpose and Objectives of the Study

Due to the delays in obtaining equipment during the first year of the project and because the project was moved to George Peabody College in Nashville, Tennessee for its second year, the objectives of this research program were modified. The original objectives, as stated in the grant application, are listed in Figure 1. The revised list of objectives, Figure 2, was included in the Autumn Quarterly Report, December 1978. The following objectives reflect the types of data collected on participants and other pertinent activities in this research and evaluation program. The findings are reported using these objectives.

Objective 1. User satisfaction and the reliability, practicality, and maintainability of the PBR.

This objective was pursued in Ohio and Tennessee with all participants involved with the PBR.

Objective 2. Identify a population of visually impaired persons and other persons willing to cooperate in this research effort.

This objective was added in the second year of this grant to enable finding additional participants as an ongoing activity throughout the year.

Objective 3. To assess the braille reading function of the PBR.

This objective is the revised form of two original objectives: (1) assess the readability of the PBR and (2) determine if the PBR has an effect on braille oral reading rates and braille oral reading error rates. These objectives were combined because of the close relationship of the two questions and due to the fact that the

same data were analyzed to answer these questions.

Objective 4. To assess the braille writing function of the PBR.

This objective remained unchanged and the data were collected in Ohio and Tennessee for the evaluation of the braille writing function of the PBR.

Objective 5. To identify patterns of use of the PBR, including reading styles, writing styles, and the way the PBR is used in daily activities of the subjects.

Behavioral observation data were collected in Ohio for this objective. Additional informal observations were made in Tennessee.

Objective 6. To develop the capability to produce braille reading materials on cassettes.

This objective was added in October, 1978 because PBR reading materials were difficult to obtain and several braille production possibilities needed to be explored, including hand transcription and computer-generation of braille cassettes.

Two of the original objectives were eliminated due to time constraints and inappropriateness of the objective in light of the data collected. The objective - examine the feasibility of administering standardized tests with the PBR by comparisons with conventional methods - was determined inappropriate due to the finding that subjects required more time to learn how to operate the equipment than would be permissible for testing circumstances. In particular, high school-aged children required three to four half-hour sessions before becoming proficient in operating the PBR. Younger children required a longer training period. In addition, the oral reading rate findings (objective 3) indicate that users do not read with

the PBR at rates comparable to their conventional reading rates, and thus these rates would not reflect the child's performance under conventional reading conditions.

The second objective - design and evaluate innovative treatments based on the PBR, that have the potential to improve braille reading skills, including reading rate and comprehension - was partially achieved, in that possible treatments to increase reading rates were developed. However, time constraints and the unavailability of school-aged subjects during the summer months, limited the implementation and evaluation of these potential treatments. These treatments will be proposed in the future research section.

Figure 1

Original Objectives - from Grant Proposal, 1977

1. User satisfaction; practicality; reliability; and maintainability of the PBR.
2. To assess the readability of the PBR.
3. To assess the braille writing function of the PBR.
4. To identify patterns of use of the PBR, including reading styles, writing styles, and the way in which the PBR is used in daily activities of the subjects.
5. To determine if the PBR has an effect on braille oral reading rates and braille oral reading error rates.
6. To examine the feasibility of administering standardized tests with the PBR by comparisons with conventional methods.
7. To design and evaluate innovative treatments, based on the PBR, that have the potential to improve braille reading skills, including reading rate and comprehension.

Figure 2

Revised Objectives - from Autumn Quarterly Report, December, 1978

1. Determine user satisfaction, practicality, reliability, and maintainability of the PBR.
2. Identify a population of visually impaired persons and other persons willing to cooperate in this research effort.
3. Assess the braille reading function of the PBR.
4. Assess the braille writing function of the PBR.
5. Develop the capability to efficiently produce braille reading materials on cassettes.

Objective 1

Identify a population of visually impaired persons and other persons willing to cooperate in this research effort.

Rationale: In order to assess the practicality of the PBR with a wide variety of users, all age groups of subjects should be sampled. As many subjects as possible should have the opportunity to use the PBR and to gain experience with the PBR in order that the final recommendations of this research project will be generalizable to other visually impaired potential users of the PBR. Therefore, attempts were made to interest elementary, secondary, college students and other visually impaired individuals in the community in using the PBR and in cooperating with project staff in data collection procedures.

Method:

1. Identify the educational alternatives available to the visually impaired in the metropolitan areas.
2. Make a presentation to interested teachers of the visually impaired in the metropolitan area to solicit their support and to volunteer prospective subjects.
3. Identify subjects for this research effort.
4. Meet with each subject to arrange future schedule of visits and research activities.
5. Obtain subject characteristics by means of the Survey Interview Form.

Columbus, Ohio

Mrs. E. Gullion, Director of the Program for the Visually Handicapped, Metropolitan Columbus Public Schools, identified braille reading children in the 1st, 3rd, 6th, 7th, 8th and 11th grades. Of these potential candidates, four were chosen to participate in this evaluation and research program.

The Ohio School for the Blind, located in Worthington, Ohio, a suburb of Columbus, includes programs for visually handicapped children in Kindergarten through the 12th grade, as well as for multi-handicapped children. The Ohio School

for the Blind personnel were a source of advice and consultation for the project. Dr. Dennis Holmes, Superintendent, Ohio School for the Blind, gave assurance of the School's interest in the equipment and their cooperation in project activities. Four children from the Ohio School participated in this project.

Seven adult members of the Columbus area volunteered to participate in this research project. They were contacted by project staff through the Ohio State University Office for the Physically Impaired.

Time commitments to the project devoted by each subject varied; some spent a few days a week working with the machine while others used the machine daily in their various professions, ranging from housewife to student to computer programmer.

The educational and demographic characteristics of these subjects were collected by the administration of the Survey Interview Form (Appendix 1). Figure 3 is a chart of the characteristics of the child users of the PBR and Figure 4 is a chart of the characteristics of the adult users. These data will be discussed below.

Nashville, Tennessee

Early in October, 1978, the local Nashville Metro School System was contacted. It was established that the Tennessee School for the Blind provided residential and day school services for the visually impaired children statewide. However, the Metro School System hired itinerant teachers to provide services for those visually impaired

Figure 3

CHILD USER CHARACTERISTICS

Subject No. 17	School	Grade	Sex	Age	Years in Class For Visually Handicapped	Age of Onset of Visual Impairment	Etiology of Visual Impairment	Present Degree of Vision	Reads Braille Only	Received Initial Braille Instruction	Began Reading Braille by	Began Reading with Grade 1 Grade 2 Braille	Received Braille Instruction	Materials Read Most Often	Reading Mechanics Which Hand Used	Which Fingers Used	Book Position	Learned to write Braille
1-0	Cols. Public	3	F	9	6	Unknown	Unknown	L.P.	Yes	Pre-School	Alphabet	2	Classroom Teacher	Books, Magazines	Right	R 1	Parallel to body	Same time as reading
2-0	Cols. Public	6	F	12	5	Unknown	Unknown	None	Yes	Grade 1	Alphabet	2	Classroom Teacher	Books, Magazines	Both	L4,3,2,1 R1,2,3,4	On Lap	Same time as reading
3-0	Cols. Public	8	F	14	9	Unknown	Unknown	L.P.	Yes	Grade 1	Alphabet	1	Classroom Teacher	Books, Magazines	Right	R 1	On Lap	---
4-0	Cols. Public	11	M	19	6	Unknown	Unknown	None	Yes	Kindergarten	Alphabet	2	Classroom Teacher	Books, Magazines	Both	R 1	On Lap	After reading
5-0	OSSB	12	M	19	14	Unknown	Unknown	None	Yes	Kindergarten	Alphabet	2	Classroom Teacher	Books	Both	L 1 R 1	Parallel to body	---
6-0	OSSB	12	M	19	14	Unknown	Unknown	None	Yes	Kindergarten	Alphabet	2	Classroom Teacher	Books	Both	L 1 R 1	Parallel to body	After reading
7-0	OSSB	9	F	16	5	Unknown	Unknown	None	Yes	Kindergarten	Alphabet	1	Resource Teacher	Books	Both	L 1 R 1	On Lap	After reading
8-0	OSSB	9	F	15	10	Unknown	Unknown	None	Yes	Kindergarten	Alphabet	2	Classroom Teacher	Magazines	Both	L 1 R 1	Parallel to body	After reading
1-7	TSSB McGavock	11	M	17	11	Birth	cataracts & detached retina	None	No Optacon	Grade 1	Alphabet	1	Classroom Teacher	Books, Magazines	Both	L 1 R 1	Straight on desk	Same time as reading
2-7	TSSB McGavock	11	F	16	8	Birth	cataracts & detached retina	None	No	Grade 3	Alphabet	1	Itinerant Teacher	Magazines	Right	R 1	All posi- tions	Same time as reading
3-7	TSSB McGavock	12	M	18	12	Birth	Esotropia & retinal dys- plasia	Partial sight	No Large Print	Grade 1	Alphabet	1	Classroom Teacher	---	Both	L2,1 R1,2	Parallel to body	Same time as reading
4-7	TSSB McGavock	10	M	15	10	Birth	cataracts & optic atrophy	None	No Optacon	Grade 1	Alphabet	1	Classroom Teacher	Books	Left	L 1	On Lap	Same time as reading
5-7	TSSB McGavock	11	M	19	8	Birth	hyperplas- tic primary vitreous & retinal folds	None	No	Grade 2	Alphabet	1	Special Teacher	Books	Both	L2,1 R1,2	Parallel to body	Same time as reading
6-7	TSSB McGavock	11	F	17	9	2 yrs.	retrolental fibroplasia	L.P.	No Optacon	Grade 1	Alphabet	1	Classroom Teacher	Books, Magazines	Both	L 1	Parallel to body	Same time as reading
7-7	West End Jr. H.S.	7	M	13	7	Birth	Unknown	None	Yes	Kindergarten	Alphabet	Combination 1 & 2	Special Braille Instr.	Books, Magazines	Both	L 1 R 1	Parallel to body	Same time as reading
8-7	Harris- William	Ungraded	M	15	0	Birth	Head trauma at age 2, progressive blindness (epilepsy)	None	Yes	Unknown	Alphabet	1	Itinerant Teacher	Books, Bible	Left	L 1	Parallel to body	After some reading
9-7	Harris- William	Ungraded	F	13	3	13 yrs.	Unknown (spina bi- fida)	L.P.	No	Grade 1	Alphabet	1	Special Braille Instr.	Homework	Both	L 1 -R 1	Parallel to body	Same time as reading
Residential-41.25 Public Schl.-58.86 Grade 6-8 35.35 Grade 9-12 64.75 H-52.95 F-47.15 Av. Age 15.6 yrs. K-8 12.6 yrs. 9-12 17.2 yrs. Av. Yrs. 8.6 Birth-41.25 Unkn.-47% 2 yrs.-5.9% 13 yrs.-5.9% Congenital cataracts- 17.6% RLF-5.9% Other-17.6% L.P.- 23.5% None- 70.6% Partial sight- 5.9% Braille only- 82.4% Braille & Opta- con-17.6% Preschool - 5.9% Kindergarten- 35.35 Grade 1-41.19 Grade 2-5.9% Grade 3-5.9% Other-5.9% 100% Alphabet Grade 1 = 58.86 Grade 2 = 35.35 Both = 5.9% Classroom Teacher = 84.7% Resource Teacher = 5.9% Itinerant = 11.7% Special = 5.9% Braille Instructor = 11.8% Books = 23.5% Magazines = 11.8% Books & Magazines = 47% Bible = 5.9% Homework = 5.9% N/R = 5.9% Right-17.6% Left-11.8% Both-70.6% 1 Finger = 35.3% 2 Fingers = 47% 4 Fingers = 11.8% None than 4 Fingers = 5.9% Parallel to body = 58.86 On lap = 29.4% On desk = 5.9% All positions = 5.9% Same time-58.86 After-29.4% N/R-11.8%																		

N/R = No Response

Figure 4
ADULT USER CHARACTERISTICS

Subject N=1	School	Grade	Sex	Age	Years in Class for Visually Handicapped	Age of Onset of Visual Impairment	Etiology of Visual Impairment	Present Degree of Vision	Reads Braille Only	Received Initial Braille Instruction	Was Taught Braille Using	Grade Began Braille	Received Initial Braille Instruction From	Do You Read	Materials Read Most Often	Reading Mechanics- Which Hand Used	Which Fingers	Book Position	Writing Braille
1-0	N/A	N/A	M	U/K	U/K	U/K	U/K	None	Optacon	Kindergarten	Alphabet	Grade 2	Classroom & Residential	Avidly	Books Magazines	Both	L 3,2,1 R 1,2,3	Slanted Left On Lap	U/K
2-0	N/A	N/A	M	U/K	U/K	U/K	U/K	L.P.	Optacon	Kindergarten	Alphabet	Grade 1	Classroom & Residential League for Blind	Rarely	Books Recipes	Right	R 1	Slanted Left	U/K
3-0	N/A	N/A	F	U/K	U/K	U/K	U/K	None	No	17 years of age	Alphabet	Grades 1 and 2	---	Avidly	Books	Both	L 1 R 1,2	Parallel to Body	U/K
4-0	N/A	N/A	M	U/K	U/K	U/K	U/K	None	No	---	---	---	---	---	---	---	---	---	U/K
5-0	N/A	N/A	M	U/K	U/K	U/K	U/K	None	---	---	---	---	---	---	---	---	---	---	U/K
6-0	N/A	N/A	M	U/K	U/K	U/K	U/K	None	Optacon	---	---	---	---	---	---	---	---	---	U/K
1-T	Peabody	Graduate	F	26	None	Birth	Retrolental Fibrosis	None	Yes	Kindergarten	Whole Words	Grade 2	Itinerant Teacher	Avidly	Technical Material Books Magazines	Right	L 3,2,1	Parallel to Body	Same Time as Reading
2-T	Peabody	Graduate	F	36	None	26	Progressive myopia, detached retina	None	Yes	12 years of age	Alphabet	Grade 1	Housemother Rehab. Ctr.	Rarely	Books	Left	L 1	Parallel to Body on Lap Down	Same Time as Reading
3-T	Peabody	Graduate	M	23	9	5	Measles	None	Yes	Grade 1	Alphabet	Grade 1	Classroom Teacher	Avidly	Books	Both	L 1 R 1	Lying Down	Same Time as Reading
4-T	Peabody	Graduate	M		5	6	Measles	None	Yes	Grade 3	Alphabet	Grade 2	Classroom Teacher	Avidly	Books, Magazines	Both	L 1 R 1	Parallel to Body	After Some Reading Skill was Developed
5-T	Peabody	Graduate	F	30	None	Birth	Cataracts & secondary glaucoma	None	Optacon	Kindergarten	Alphabet	Grade 2	Teacher Mother	Avidly	Books, Magazines	Right	R 1,2,3	Slanted Right	Same Time as Reading
6-T	Peabody	Junior	F	21	13	Birth	Optic nerve not developed	L.P.	Yes	Kindergarten	Alphabet	Grade 2	Classroom Teacher	Avidly	Books, Magazines	Right	R 1	Parallel to Body	Same Time as Reading
7-T	Peabody	Senior	F	23	7	Birth	Retrolental Fibrosis	None	Yes	Grade 5	Whole Words	Grade 1 1/2	Special Br. Instructor	Occasion- ally	Talking Books	Both	L 1 R 1	Parallel to Body	Same Time as Reading
Peabody 54% N/A 46% Graduate 38% Under-graduate 16% N/A 46% M 54% F 46% Av. Age 26 yrs. U/K 46% Av. yrs. = 4.8 U/K = 46% Birth 30.7% Av. age 12.3 yrs. U/K 46% U/K 46% RLF 15.4% Detached Retina 7.6% Measles 19.3% Cataracts 7.6% Optic Nerve 7.6% None 84.6% LP 15.4% No-Optacon 46% U/K 7.6% Yes 46% No-Optacon 46% U/K 7.6% Kindergarten 38.5% Elementary 23% Secondary 15.3% U/K 23% Alphabet 61.5% Whole Words 15.4% U/K 23% Grade 1 23% Grade 1 1/2 15.4% Grade 2 38.4% U/K 23% Classroom 38% Itinerant 7.6% Special Braille 7.6% Other 23% N/A 23% Avidly 53.8% Occasion-ally 7.6% Rarely 30.7% N/A 7.6% Books 69.2% Magazines 46% Other 23% Both 53.8% Right 30.7% Left 7.6% U/K 7.6% 1 finger 30.7% 2 fingers 23% 3 or more fingers 30.7% U/K 7.6% Parallel 46% Slanted left 15.3% Slanted right 7.6% Lying down 15.3% On lap 15.3% U/K 7.6% Same Time as Reading 46% After Reading 7.6% U/K 46%																			

N/A = Not Applicable
U/K = Unknown

children in the local schools.

Dr. Gary Coker, Principal, arranged for project personnel to make a presentation at the Tennessee School for the Blind for all interested language arts teachers at the Tennessee School for the Blind and for the Metro Schools itinerant teachers in November, 1978.

As a result of this presentation, six high school students at the Tennessee School for the Blind were volunteered to participate. Figure 3 is a chart of their educational and personal characteristics. These six students were chosen because the teachers felt they could use the PBR for note-taking at the local high school they attend for several classes.

Three itinerant teachers volunteered visually impaired children in their classes to participate in this research program. One child was a 7th grader; the other two were multiply-handicapped braille readers in ungraded classrooms. The educational and demographic characteristics of these students are represented in Figure 3.

Michelle Bourgeois contacted visually impaired students at George Peabody College for Teachers; seven undergraduate and graduate students have participated in this research program. The educational and demographic characteristics of these subjects are charted in Figure 4.

Other adult braille readers have used the PBR for short periods of time and have submitted evaluations of the equipment; however, as they did not participate in the data collection and research activities, their educational and demographic characteristics

are not included in Figure 4. Their evaluations of the equipment are included in the Figures under Objective 2.

Case studies for all participants in this research and evaluation project are included in Appendix 2.

Child User Characteristics

A total of seventeen children in Ohio and Tennessee participated in this research project. Of these children, 41.2% attended the residential schools (Ohio and Tennessee Schools for the Blind) and 58.8% attended local day schools in the Columbus and Nashville metropolitan areas. A majority of the children (64.7%) were in Grades 9-12, and the remainder (35.3%) were in grades 3-8. Approximately 52.9% were male and 47.1% were female. The average age of the children was 15.6 years. For the children who were able to report this information, 41.2% became blind at birth. Congenital cataracts, retrolental fibroplasia, and other disorders accounted for most of the etiologies. The majority of the children (70.6%) had no remaining vision; 23.5% had light perception; and 5.9% had partial sight. Consequently 82.4% of the children read only braille, and 17.6% of them used the Optacon and some large print.

Educationally, the majority of the children received their initial braille instruction in kindergarten or first grade, using the alphabet and grade 1 braille. As a group, the children had spent an average of 8.6 years in classes for the visually impaired. Sixty-four percent of the children received their braille instruction from their classroom teachers.

With regard to reading mechanics, 70.6% of the children read with both hands and usually 1 or 2 fingers. The children generally preferred to read magazines and books parallel to their body. Most children (58.8%) learned to write braille at the same time as they learned to read braille.

Adult User Characteristics

The adult participants in Ohio were professional people (computer programmers) and housewives; the adult participants in Tennessee were all students at George Peabody College. The group as a whole was evenly distributed between male (54%) and female (46%). Their average age was 26 years. The majority of these adults were blinded at birth from a variety of causes, including retrolental fibroplasia, detached retina, measles and cataracts. Eighty-four percent of these adults had no remaining vision, and the remainder had light perception (15.4%).

Educationally, a majority of these adults learned to read braille in kindergarten and elementary school, using the alphabet. Participants were equally likely to read braille (46%) or to read both braille and optacon (46%). Classroom teachers taught 38% of these adults as children to read braille; various other teachers instructed the others.

These adults reported to read books and magazines avidly (53.8%), using both hands (53%) and generally one to two fingers. These participants preferred reading with the book positioned parallel to their body. And, in general, they learned to write braille at the same time as they learned to read braille.

Objective 2 Determine user satisfaction, practicality, reliability, and maintainability of the PBR.

Rationale

User satisfaction and practicality are two interrelated variables on which the PBR must be evaluated; these two variables will determine in great part the degree to which users will benefit from the PBR because satisfaction and practicality will influence frequency and duration of use. Unless users are highly satisfied with the PBR and its practicality, there is little reason to suspect that it will serve as a supplement to or as a superior substitute for current approaches to braille reading, writing, and audio recording.

Reliability and maintainability of the PBR are also essential characteristics. If the PBR does not consistently input-output that which it is intended to, a reader would find it difficult to be satisfied with the unit. Similarly, if the PBR required lengthy and difficult, or expensive maintenance, then users will not have access to it and subsequently will benefit little from it.

Subjects

All of the individuals who participated in the various aspects of the project served as sources of data by which the characteristics of the PBR were determined. They included blind children and adults, educators, other professionals, and graduate research associates.

Method

1. All subjects received at least one or two hours of intensive orientation to and demonstration of the PBR by project staff. Children generally received 4 hours of instruction. Subjects were encouraged to take the equipment home with them and to practice using the machine in its various modes.

2. The project staff kept a log of Subject comments, equipment malfunctions, and other related problems. Subjects were asked to develop a comprehensive list of problems with and suggestions for using the PBR.

3. Project participants were asked to complete the Checklist for Evaluating Braille Equipment (See Appendix 3) and the PBR Research Program Rating Scale (See Appendix 4) at the termination of their involvement with this project. This information supplemented material collected by project staff (daily log, subject comments, lists of problems and suggestions). The Checklist for Evaluating Braille Equipment includes items used in the Lowenfeld, Abel and Hatlen (1969) study.

Results

Data collected will be discussed in the following sequence:

1. User satisfaction with the PBR and PBR practicality.
2. Reliability and maintainability of the PBR.
3. User Satisfaction/PBR Practicality

All participants in this project who received instruction in using the PBR answered questionnaires (Program Rating Scale and Checklist for Evaluating Equipment) and contributed written and verbal comments about their satisfaction with the PBR and its practicality. All participants were more satisfied with the PBR than they were dissatisfied; they were able to suggest an equal number of positive and negative attributes of the PBR.

Based on results of the PBR Research Program Rating Scale tabulated in Figure 5, the Perkins Braille was judged to be heavier, larger in size, and louder than the PBR. The keyboard height of

Summary Table

PBR Research Program Rating Scale

"The Perkins Brailier was judged to be ____ compared to the PBR."

	Children-Ohio N=8	Adults-Ohio N=6	Children-Tennessee N=6	Adults-Tennessee N=8
1. Ease of Handling				
Easier	37.5%	50%	33.3%	37.5%
Harder	50%	50%	50%	50%
Same	12.5%		16.6%	12.5%
2. Weight				
Lighter		16.6%		12.5%
Heavier	87.5%	66.6%	83.3%	87.5%
Same	12.5%		16.6%	
N/R		16.6%		
3. Size				
Smaller		16.6%	16.6%	12.5%
Larger	100%	83.3%	83.3%	87.5%
Same				
4. Noise Level				
Quieter		16.6%		12.5%
Louder	100%	83.3%	100%	87.5%
Same				
5. Keyboard height				
Easier	12.5%	16.6%	16.6%	25%
Harder	25%	16.6%		12.5%
Same	62.5%	66.6%	83.3%	62.5%
6. Portable				
Less	25%	50%	50%	75%
More	75%	33.3%		25%
Same		16.6%	50%	
7. Compactness				
Braille	25%	83.3%	33.3%	37.5%
PBR	62.5%	16.6%	16.6%	37.5%
Same	12.5%		50%	25%
8. Brailling				
Easier	12.5%	50%	33.3%	50%
Harder	37.5%	33.3%	16.6%	25%
Same	50%	16.6%	50%	25%
9. Touch Perception				
Easier	50%	50%	16.6%	50%
Harder				12.5%
Same	50%	50%	83.3%	37.5%
10. 12-cell Braille display				
Satisfactory	25%		33.3%	25%
Disadvantage	50%	66.6%	50%	50%
Liability	25%	33.3%	16.6%	25%
11. Flexible				
Yes	75%	33.3%	83.3%	62.5%
No		66.6%	16.6%	37.5%
No Answer	25%			

the Perkins Brailler was judged to be the same as the PBR, as was the tactile perception of the braille dots produced on paper or on the PBR. Results were equivocal on questions concerning the portability of the machines, the compactness of paper braille versus cassette braille, and the difference in ease in braille with the two machines. The participants largely agreed that the 12-cell display of the PBR was either a disadvantage or a liability; however, they could see the advantages the PBR offered in terms of flexibility of reading materials and braille storage.

Based on the results of the Checklist for Evaluating Braille Equipment (Figure 6), the participants agreed that the PBR was a valuable and versatile machine, that cassettes were more efficient than paper, that the PBR was small, compact and easily portable, and that the lack of noise was an advantage. However, they did not rate the PBR very well in terms of reading ease and speed and writing ease and speed.

Subjects were all interviewed at the end of their participation in the study. Figure 7 is a compilation of the features most often mentioned as being satisfactory. Figure 8 is a compilation of the features most often mentioned as being unsatisfactory. Appendix 5 contains verbatim transcripts of students' verbal and written comments concerning the PBR. Based on all of these comments, it was found that participants most often mentioned the following advantages of the PBR. They liked being able to take notes in braille during the class period without using the slate and stylus or Perkins Writer. The noiseless feature of the PBR contributed to their satisfaction with taking notes in class with the PBR because they felt they were not disturbing classmates.

Figure 8

SUMMARY TABLE

Checklist for Evaluating Braille Equipment

On a scale of 1 to 7, the PBR was judged to be:	Children--Ohio N=8	Adults--Ohio							Children--Tennessee							Adults--Tennessee								Total X	
		1	2	3	4	5	6	X	1	2	3	4	5	6	X	1	2	3	4	5	6	7	8	X	
Weight & Size																									
1 Heavy-7 Light	5.87	3	6	3	7	6	7	5.3	5	6	5	3	4	7	5.0	3	5	5	7	5	6	4	3	4.7	5.2
1 Large-7 Small	5.75	4	6	5	7	6	4	5.3	6	7	5	7	5	7	6.1	5	5	5	7	5	6	4	2	4.8	5.48
1 Cumbersome- 7 Easy to Handle	----	4	5	4	3	6	7	4.8	2	5	7	7	4	4	4.8	7	6	1	6	6	6	7	6	5.6	5.0
1 Not Easily Portable- 7 Portable	6.12	4	6	3	7	7	7	5.6	2	6	7	7	6	7	5.8	7	6	7	7	6	7	7	6	6.6	6.03
1 Bulky-7 Compact	5.24	5	5	6	7	6	7	6.0	4	7	7	5	5	5	5.5	7	7	7	7	5	6	7	3	6.1	5.71
Noise Level																									
1 Loud-7 Quiet	5.75	7	7	7	7	6	7	6.8	6	6	7	5	5	5	5.6	6	5	7	7	4	7	7	7	6.1	6.06
Reading Ease																									
1 Unsatisfactory- 7 Satisfactory	4.12	1	5	4	1	5	7	3.8	5	5	4	6	4	5	4.8	6	4	1	6	4	2	5	1	3.6	4.08
Reading Speed																									
1 Slow-7 Fast	3.5	1	5	3	3	3	4	3.1	5	4	4	4	4	4	4.1	5	6	1	4	1	2	7	4	3.7	3.6
Writing Ease																									
1 Unsatisfactory- 7 Satisfactory	6.00	3	6	6	1	7	7	5.0	3	5	7	4	3	7	4.8	6	6	7	7	6	4	7	2	5.6	5.35
Writing Touch																									
1 Unresponsive- 7 Responsive	6.25	2	7	6	7	6	7	5.8	2	6	7	2	5	7	4.8	5	7	7	7	6	4	7	7	6.2	5.76
Writing Speed																									
1 Slow-7 Fast	5.0	4	5	7	7	6	7	6.0	2	5	4	7	6	7	5.1	7	5	7	7	7	5	7	5	6.2	5.57
Preparation for Use																									
1 Difficult-7 Easy	4.75	1	7	3	1	5	4	3.5	2	4	6	7	7	7	5.5	5	3	7	7	5	6	3	2	4.7	4.6
Materials																									
1 Bulky-7 Compact	6.125	7	7	6	7	6	7	6.6	4	7	7	7	7	7	5.3	7	7	7	7	7	7	7	7	7.0	6.25
1 Unavailable- 7 Available	5.6	1	7	2	2	5	1	3.0	4	4	4	4	7	7	5.0	7	7	7	7	7	2	4	7	6.0	4.9
1 Inefficient- 7 Efficient	6.125	1	7	6	2	4	1	3.5	4	6	7	5	3	7	5.3	5	6	7	7	6	3	4	3	5.1	5.0
Material Output																									
1 Undesirable-7 Desirable	4.625	1	5	3	1	6	4	3.3	4	5	5	5	1	5	4.1	5	5	7	7	5	4	5	7	5.6	4.4
Overall Use																									
1 Restrictive-7 Versatile	6.0	1	6	6	5	5	7	5.0	6	6	7	7	6	7	6.5	6	6	1	6	6	5	7	3	5.0	5.6
1 Worthless-7 Valuable	6.125	3	7	6	7	5	7	5.8	7	6	7	6	7	7	6.6	7	7	4	6	3	6	7	5	5.6	6.03

Figure 7

Features of the PBR Best Liked: Summary

<u>Feature</u>	<u>Number of Occurrences</u>
Braille on cassette--paperless Notetaking	11
Correction feature	6
Ease of brailleing	3
Storage feature--braille	6
Counter buttons	4
Quietness when brailleing	10
Audio recording	4
Portability	5
Don't have to braille backwards	1
Easy to operate	1
Size and Weight	2
Versatility	2
Braille dots	1

Figure 8

Features of the PBR Least Liked: Summary

<u>Feature</u>	<u>Number of Occurrences</u>
12-Cell display too short, chops words	17
One-finger reading	1
Pins--inconsistent display	3
Keyboard	6
Battery	7
Complex to operate	2
Sensitive to touch/touch switch	7
Reading is slower	2
Warning tone	6'
Counter unsatisfactory	2
Gravity switch	4
Changing block too long	4
Cost	3
Poor audio quality	2
No search capability	2
No handle	1
Cassette damage	1

Participants equally mentioned the advantages of the PBR's size, weight, and portability and the PBR's backspace/correcting feature. Participants overwhelmingly agreed that the PBR's 12-cell display was a disadvantage because it slowed down reading speed and divided words without regard to syllabification rules. The touch control switch was often regarded as a disadvantage because one had to be careful not to accidentally touch it and because changes in environmental temperature and humidity levels could cause the line to change without touching the switch. Participants equally mentioned the disadvantages of the gravity switch (having to turn the machine on its side to put it in the reading mode) and the time elapsed during the transfer of a block of information to the buffer memory.

2. Reliability and Maintainability of the PBR

A log of equipment problems and malfunctions was kept by project staff (See Appendix 6). Figure 9 is a summary of the types and frequency of machine malfunctions. Figure 10 is a breakdown of the number of equipment malfunctions by machine and by year.

During the first year of the project, equipment malfunctions impeded data collection activities. Although eight children and six adults used the PBRs between January and July, 1978, their use was intermittent and irregular due to equipment problems and the lack of reading materials. During the months of July and October, 1978, all PBRs were returned to Washington, D.C. for servicing and refurbishing. All batteries were replaced for the second time, but it is unclear what specific repairs were done and what machine modifications were made. However, when data collection activities resumed in Nashville, Tennessee in October, all machines were functional. Detailed operating instructions and trouble shooting directions were written (see appendix 18 "Digicassette Operating Manual"); all subjects received instruction from project staff until they could reliably handle minor equipment malfunctions independent of project staff. This was done to insure that equipment problems interfered as little as possible with data collection activities and with the satisfactory use of the machine.

Although thirteen machines* were in constant use during the months of December, 1978 through May, 1979, the original intent was to keep 8 machines in operation and to keep two for back-up and transcriber use. Throughout the summer months of June, July, and August, 1979, six machines were in constant use. During those nine months, a total of 22 equipment problems that required project staff

*Project funds purchased 10 machines. The additional equipment was obtained on loan from American Printing House for the Blind (two machines) and ELINFA (one machine).

Figure 9

Equipment Malfunctions - Summary

<u>Type of Problem</u>	<u>Frequency of Occurrence</u>
Braille Mode - Recording/Playback	17
Audio Mode - Recording/Playback	4
Batteries	11
Braille display, pins	12
Cassette Tape	2
Key tops/springs	2
User Error	1
Cassette door	2
Touch Switch/control	4
Total:	55
Number of Times machines returned to Washington for repairs	15

Figure 10

Number of Equipment Malfunctions by Machine & Year

<u>Machine #</u>	<u>Jan. - Sept. 1978</u>	<u>Oct. 1978 - Oct. 1979</u>
10126	3	2
10127*		0
10128	3	3
10129	2	1
10132	1	1
10133	2	1
10136	4	2
10137	3	4
10138	2	2
10140	3	2
10142**		2
10144*	1	2
10145	2	0
	N=11	N=13
Total;	26	22
Average Number of Malfunctions:	2.36	1.69
Range	0-4	0-4
Number Returned to Washington for Repairs:	6	9
Combined Years I and II range per machine	2-7	

*APH machine, on loan

**ELINFA machine, on loan

intervention occurred. Of those, six problems were easily taken care of by project staff; these included: battery problems, a broken cassette tape and a cassette door problem. A total of nine machines were returned to ELINFA for repairs due to machine malfunctions. The remainder of machine problems were solved by project staff; these included adjusting voltage regulator on the external power supply, an electrical short in external power supply, missing springs in keys, and humidity/temperature changes causing touch switch to malfunction. The poor audio recording quality of the tape recorder was never solved by either project staff or ELINFA personnel.

In general, the PBR could be reliably maintained with proper usage. It was found that battery-related malfunctions were a significant cause of braille recording and playback problems.

Figure 9 is a summary of the types and frequency of equipment malfunctions for all machines during the two years of duration of this project. Of a total of 55 equipment malfunctions, 17 were related to recording or playback problems in the braille mode, 12 were due to broken or the inconsistent height of the pins in the braille display, and 11 were directly related to the batteries. Less frequent problems included four instances of problems with the recording and playback functions in the audio mode, four instances of inconsistencies with the touch control switch, two broken cassette tapes, two instances of the key tops losing their springs, two instances when edge of the cassette door slid underneath the machine case and would not open, and one instance of user error. Although there were 55 instances of equipment malfunctioning, machines were returned to ELINFA for repairs only 15 times. Project staff were able to instruct subjects in ways to

correct the problems or were able to remedy the situation themselves.

Figure 10 illustrates the number of equipment malfunctions by individual machine and by fiscal year of the project. There were a total of 26 equipment malfunctions between January and September, 1978 and 22 equipment malfunctions between October, 1978 and October, 1979. The average number of malfunctions per machine was calculated to be 2.36 per machine for year I and 1.69 per machine for year II, with a range of 2-7 equipment malfunctions per machine for year I and II combined. A total of six machines were returned for repairs during Year I and 9 machines for year II.

Types of Problems Encountered with the PBR

The most frequent electronic problem with the PBR was the braille recording and playback malfunction. The problem can be defined as: when the PBR was readied for operation in the braille reading mode, the tape transport mechanism would operate as in the audio recording or playback mode. Although the ELINFA company could fix this problem in their Washington, D.C. office, they would not explain the nature of the problem.

The second most frequent problem encountered was the malfunction of the pins in the braille display. The pins are operated by delicate piezoelectric reeds which raise and lower the pins. Because the reeds are so fragile, they often break if the PBR is dropped on a table or the floor. Whenever reeds are broken, the corresponding pin no longer raises or lowers in the braille display, and the PBR has to be sent to ELINFA for repairs.

The third most frequent problem concerned the batteries. Because of the relatively short battery-life of the batteries (2-3 hours) participants often discharged the batteries of their PBR while in use. During Year I of this project, project staff often misdiagnosed equipment malfunctions as more serious than simply a discharged battery. However, it was then discovered that recharging the batteries for 6-8 hours, or that using the PBR when plugged into a wall outlet would significantly decrease the number of equipment problems. Another problem with the batteries was the occasional overcharging of the batteries if subjects left the PBR plugged into a wall socket overnight, or longer than 8 hours, the PBR would not operate. Instructing subjects in the proper length of time to charge batteries decreased the frequency of this problem. Nevertheless, battery-life problems remain frequent. Recommendation will be made to ELINFA to increase the battery life of the PBR.

Several participants encountered problems with the PBR's tape recorder. Complaints concerned the quality of the tape recordings made with the PBR. In particular, recordings were noticed to have a distinct "hum" to them. Recommendation will be made to improve the quality of the audio tape recording component of the PBR.

Sensitivity to humidity and temperature resulted in inconsistencies in operation of the touch control switch. Although inconvenient, this problem was usually remedied by changing the humidity level of the operator's fingers or by allowing the PBR time to acclimatize itself to the temperature and humidity level of the room. Subjects whose palms and fingers were consistently moist had the most difficulty with the touch control switch. These participants

expressed the desire to have a push button touch switch or some other type of control to change the display line. It would be interesting to study the ability of PBR users to read with a PBR with the present touch control switch and of PBR users to read with an experimental model of the PBR with an alternate line-changing switch/control. Another possibility would be to move the touch control switch to the beginning of the braille display at the left hand corner.

Problems with cassette tapes were few. Only two cassette tapes were found to have been destroyed inside the digicassette. No one brand of cassette tape was found to be less satisfactory than another. However, it is hypothesized that higher quality tapes will have a longer life under conditions of constant and/or frequent use.

Several participants encountered problems with the key tops of the PBR. Because the keys are raised, objects such as sleeve cuffs get caught under the edge of the key top and lift the key top off the key. There is a small spring inside the key which can fall out when key tops are knocked off, rendering the machine and keys inoperable. The ELINFA company has modified the design of the PBR's keys in such a way that they are recessed in new machines having a 20 cell braille display. This will prevent the keytops from being accidentally removed.

Loose screws caused the tape recorder to shift in the case and caused the cassette door to get stuck underneath the edge of the PBR case. Centering the taperecorder beneath the opening in the case and tightening the screws solved this problem whenever it occurred.

Equipment Repairs

Service and repair time at ELINFA's Washington office was often unduly lengthy. The first two machines sent for repairs were returned

within four weeks. The next three machines remained in Washington a total of ten weeks.

Fortunately, the majority of equipment malfunctions were solvable by project staff. The frequency of broken pins and other serious problems requiring professional repair work was low, 8 out of 21, 38% of all problems. However, the length of time for repairs was unsatisfactory. A technical manual, including machine specifications, would have been useful to project staff; however, this was not provided by ELINFA.

It will be recommended to ELINFA that

1. A service manual be provided, including technical specifications for the equipment so that local technicians can diagnose difficulties.
2. An itemized repair cost list be provided.
3. A faster turn-around time for equipment repairs be instituted.

These problems led to dissatisfaction with the equipment. As consumers, we felt a need to be better informed about our delicate and complex piece of equipment.

Summary

In summary, subjects were more satisfied with the PBR than they were dissatisfied. They agreed that the PBR's size, weight, and noise level were positive features; they liked the advantages the PBR offered in terms of flexibility of reading materials, braille storage, and notetaking features. However, the 12-cell reading display was largely viewed as a disadvantage and even a liability of the PBR due to the fact that reading ease and speed were reduced with the PBR.

With regard to equipment reliability and maintainability, the PBR was found to be delicate and unreliable during the first year of the project. However, after project staff learned to repair and to troubleshoot equipment malfunctions, reliability and maintainability improved during the second year. In general, the PBR was found to be reliably maintainable with appropriate care and attention, particularly to the batteries. However, service and repair time at ELINFA's Washington office was lengthy and caused a general dissatisfaction with the equipment.

Objective 3 Assess the braille reading function of the PBR

Rationale: The readability of the braille display is a critical variable with respect to the utility of the PBR. A display limited to twelve characters is unique and will not have been encountered by blind readers. Further, the method by which information is put into the PBR, 120 characters encoded in a buffer and then into the cassette, causes words to be divided without regard to standard syllabication if they occur at the end of a twelve-cell line. Preliminary observations suggest that rapid accommodation can be made to this arbitrary division of words although it may at first confuse readers. How readers adapt through time to the 12-cell display will influence the utility of the PBR. Also, once a user overcomes the initial difficulty of reading the 12-cell display, he or she may attend better to the braille characters. This increased attention could conceivably generalize to all braille reading and result in increased reading and decreased error rates. Therefore, the questions to be addressed are: Is there a difference in reading rate and reading-error rate as a function of time when reading with the PBR and with conventional braille volumes; and does the PBR have an effect on braille oral reading rates and braille oral reading error rates?

The following narrative is organized in this manner:

I. Method: Ohio, Child Users

Reading Materials

Results

II. Method: Ohio, Adult Users

Reading Materials

Results

III. Method: Tennessee, Child Users

Reading Materials

Results

IV. Method: Tennessee, Adult Users

Reading Materials

Results

I. Method: Ohio, Child Users

Eight subjects were given a pre-test of their oral reading rate and oral reading error rate using conventional and cassette braille materials. Subjects read passages outloud for five minutes. Project staff monitored the time with a stopwatch. Oral reading rate was calculated by dividing the total number of words read by 5. Subjects then received instruction from project staff, who also supervised periodic practice sessions with the PBR. The regular classroom teachers of the children were also instructed in the use of the PBR and were asked to allow the child to use the PBR for daily classroom assignments. At the end of the school year, all subjects received a post-test of their oral reading rate and oral reading error rates using conventional and cassette braille materials. Recordings were

made, transcribed, and analyzed for oral reading and error rates. The error rate is defined as the number of errors in reading per minute read during the five one-minute timed intervals of the session. Responses scored as errors include:

- a) hesitations, dysfluencies
- b) repetition of sound, letter, word, phrase
- c) incorrect word
- d) substitution of one word for another
- e) omission of words
- f) inclusion of extra words
- g) omission or repetitions due to improper handling of equipment

Reading Assessment Materials

Three passages of graded difficulty were chosen and brailled for reading of conventional braille for each grade level grouping. Three passages were also chosen and brailled on cassette tapes for PBR reading. The grade level groupings are third grade, junior high, and senior high. Each passage was read and recorded for six minutes. Six passages of graded difficulty were chosen for the post evaluation. Three passages were brailled for standard reading of conventional braille for each grade level: third grade, junior high, and senior high. And three passages were brailled on cassette tape for PBR reading. Each passage was read and recorded for six minutes. Recordings were made while subjects read the materials aloud. Project staff transcribed the tapes in order to calculate oral reading rate and error rate scores. Samples of the materials are included in Appendix 7.

Reading errors were analyzed using a recording system developed by Ashcroft (1960).

Results

Due to the lack of materials and indeterminate time each child used the PBR, the results charted in Figure 11 are viewed as suggestive, not definitive. However, informal reports by project staff indicate that all children reacted positively to the PBR and seemed to enjoy the time spent using it when it functioned effectively.

As shown in Figure 11, there is a significant difference in reading rate scores as a function of using the PBR or paper braille, both on pre-test and post-test measures. However, there is not a significant difference in reading rate scores as a function of time, in either reading mode. Therefore, these subjects did not appear to significantly increase their reading rates using the PBR, even though they had access to it and were reported to use it for classroom assignments.

Figure 11
Child User Reading Rates

Columbus, Ohio

Oral Reading Rates[†]

Subject	Pre		Post	
	Conv.	PBR	Conv.	PBR
1	26.7	18.26	27.6	16.61
2	119.6	71.83	125.2	70.16
3	134.8	(---)	(138.94	70.44)††
4	65.06	42.37	61.34	38.22
5	69.33	37.90	82.17	45.56
6	90.67	41.23	81.22	46.16
7	71.37	27.7	67.87	42.95
8	<u>64.53</u>	<u>30.43</u>	<u>59.56</u>	<u>37.05</u>
	$\bar{X}$ = 72.46	38.53	$\bar{X}$ = 80.48	45.89
			(72.13)	(42.38)

Group	Mean	STD	T	DF
Pre conv.	72.46	28.21	6.07**	6
Pre PBR	38.53	16.95		
Post conv.	80.48	36.21	5.17**	7
Post PBR	45.89	17.70		
Conv. pre	72.46	28.21	.1161	6
Conv. post	72.13	29.65		
PBR pre	38.53	16.95	1.49	6
PBR post	42.38	15.84		

**p. > .005

† Oral reading rates were calculated by dividing the total number of words read in five minutes by 5.

†† Scores within parentheses were not used when calculating comparisons between groups with missing data.

It is of interest to note that these subjects maintained their reading rates with regular paper braille; as shown in Figure 11, there was not a significant difference in pre-test and post-test scores when subjects read paper braille. Therefore, the oral reading rates of these subjects when reading paper braille did not appear to be adversely affected by their exposure to the PBR.

Further substantiation of these results can be seen in Figure 12 with regard to oral reading error rates in both reading conditions. Subjects did not make significantly more errors in either reading condition on pre-test and post-test measures or as a function of reading medium. Subjects appeared to make a comparable number of errors reading either paper or cassette braille materials. These results could have been expressed in terms of accuracy rates, as a percentage of words correctly read. However, as there were insignificant differences between reading conditions for numbers of errors committed, and because relatively few errors were committed (range 1 to 8 errors per minute), it was decided to use the actual error rate scores in calculating the statistics rather than the accuracy rates. However, this was an arbitrary decision.

Figure 12
Children, Ohio
Oral Reading Error Rates †

<u>Subject</u>	<u>Pre</u>		<u>Post</u>	
	<u>Conv.</u>	<u>PBR</u>	<u>Conv.</u>	<u>PBR</u>
1	3.7	3.3	1.17	8
2	3.9	5.3	1	3.5
3	(3.1	---	(2.16	2.72) ++
4	2.06	2.9	1.33	1.05
5	2.3	3.2	2.95	3.56
6	3.3	4.06	3.09	2.27
7	4.61	4.28	2.3	1.57
8	<u>8.17</u>	<u>7.06</u>	<u>7.1</u>	<u>4.65</u>
	X= 4.0	4.3	X=2.73 (2.82)	3.41 (3.51)

<u>Group</u>	<u>Mean</u>	<u>STD</u>	<u>T</u>	<u>DF</u>
Pre conv.	4.00	2.04	.857	6
Pre PBR	4.3	1.46		
Post conv.	2.73	2.01	.659	7
Post PBR	3.41	2.18		
Conv. pre	4.00	2.04	2.15	6
Conv. post	2.82	2.16		
PBR pre	4.3	1.46	.796	6
PBR post	3.51	2.33		

† Oral reading error rates were calculated by dividing the the total number of errors committed in 5 minutes by 5.

++ Scores within parentheses were not used when calculating comparisons between groups with missing data.

II. Method: Ohio, Adult Users

Five adults from the Columbus, Ohio metropolitan area participated in the evaluation study of the PBR during the months of June and July, 1978. In early June, they were given a pre-test of their oral reading rate using paper braille and cassette braille. Project staff then instructed these subjects in the use and maintenance of the equipment, allowing them to use the PBR for personal purposes. Subjects met with project staff in early July and their oral reading rates and reading error rates were established on an interim-test of reading performance. At the end of July, the post-test of oral reading rate was administered to all subjects. As stated earlier, tape recordings were made of all experimental sessions and later transcribed by project staff. Reading error rates were calculated using Ashcroft's (1960) procedures.

Reading Materials

Adult level reading materials were hand transcribed by a certified braille transcriber using the Perkins Brailler and the PBR. Equivalent passages were used for assessment purposes. Samples of the materials are included in Appendix 8.

Results

The results of adult user oral reading rate are shown in Figure 13. These adult subjects exhibited only one significant difference in performance; they demonstrated significantly faster reading rates using paper braille rather than cassette braille on the post-test of oral reading performance. This finding supports the fact that, although the adults considered the PBR a useful and interesting machine, they overwhelmingly preferred to read braille volumes (see Figure 5, Results of PBR Research Program Rating Scale).

Figure 13

Ohio: Adult User Oral Reading RatesOral Reading Rates [†]

<u>Subjects</u>	<u>Pre</u>		<u>Interim</u>		<u>Post</u>	
	<u>Conv.</u>	<u>PBR</u>	<u>Conv.</u>	<u>PBR</u>	<u>Conv.</u>	<u>PBR</u>
1	95.3	44.9	90.9	58.82	79.50	46.95
2	119.17	60.7	158.7	85.11	141.96	94.12
3	(---	---	125.0	66.01	(117.78	55.56) ^{††}
4	26.6	10.54	19.19	19.86	23.04	18.65
5	<u>102.14</u>	<u>67.21</u>	<u>68.49</u>	<u>60.06</u>	<u>96.36</u>	<u>49.5</u>
X=	85.8	45.83	X=92.45	57.97	X=91.72 (85.21)	52.95 (52.30)

<u>Group</u>	<u>Mean</u>	<u>STD</u>	<u>T</u>	<u>DF</u>
Pre conv.	85.80	40.72	4.27	3
Pre PBR	45.83	25.32		
Int. conv.	92.45	53.36	2.43	4
Int. PBR	57.97	23.76		
Post conv.	91.72	44.97	3.95*	4
Post PBR	52.95	27.04		
Conv. pre	85.80	40.72	.713	3
Conv. post	85.21	49.13		
PBR pre	45.83	25.32	.613	3
PBR post	52.30	31.18		

*p. > .01

† Oral reading rates were calculated by dividing the total number of words read in five minutes by 5.

†† Scores within parentheses were not used when calculating comparisons between groups with missing data.

Figure 14 charts the oral reading error rates of these subjects. As shown, there were no significant differences in error rates as a function of reading mode or as a function of time and experience with the PBR.

Figure 14
Ohio: Adult User

Oral Reading Error Rates[†]

Subjects	Pre		Interim		Post	
	Conv.	PBR	Conv.	PBR	Conv.	PBR
1	2.00	2.3	2.73	1.47	2.00	1.88
2	0.83	3.3	1.59	2.55	0.89	1.76
3	(---	---	3.75	2.31	(1.11	3.7) ^{††}
4	1.03	1.54	0.58	1.09	1.09	0.51
5	<u>2.5</u>	<u>1.03</u>	<u>0.00</u>	<u>1.20</u>	<u>3.94</u>	<u>0.25</u>
	X= 1.59	2.04	X=1.73	1.72	X=1.8 (1.98)	1.62 (1.1)

Group	Mean	STD	T	DF
Pre conv.	1.59	.793	.561	3
Pre PBR	2.04	.987		
Int. conv.	1.73	1.53	.107	4
Int. PBR	1.72	.66		
Post conv.	1.80	1.26	.180	4
Post PBR	1.62	1.37		
Conv. pre	1.59	.793	1.11	3
Conv. post	1.98	1.39		
PBR pre	2.04	.987	4.0	3
PBR post				

[†] Oral reading error rates were calculated by dividing the total number of errors committed in five minutes by 5.

^{††} Scores within parentheses were not used when calculating comparisons between groups with missing data.

III. Method: Child Users, Tennessee

Six students from the Tennessee School for the Blind and one student from Nashville Metropolitan Schools participated in data collection activities for this project in 1979.

Project staff met with each child individually for four half-hour sessions, during which oral reading rates using paper braille materials were established and detailed instructions were given concerning the operation and maintenance of the PBR. During the fifth session, project staff administered a criterion referenced proficiency test to insure that subjects could reliably utilize and maintain the PBR. When subjects scored 95% or better on the proficiency test, subsequent sessions consisted of oral reading assessments using the PBR, and intermittent probe assessments of oral reading with paper braille. In any one assessment session, students read aloud for five minutes, as measured by a Breitling stopwatch. The reading rate score was calculated by dividing the total number of words read by five (minutes). The length of subject participation varied as a function of the number of extra-curricular activities and academic requirements for which the subject was responsible.

Reading Assessment Materials

The same reading materials used with subjects in Ohio were utilized with these students. In addition, computer-generated fictional reading materials were available to students who requested them (see objective 6 for more details), for additional leisure reading.

Results

Figure 15 are graphs of individual subject's performance during the study. Circles represent the reading rate score in per cent

Figure B
 Graphs of Oral Reading Rates⁺
 for Seven Child Users - Tennessee

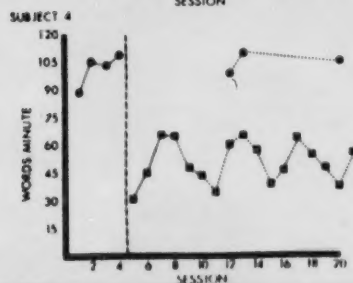
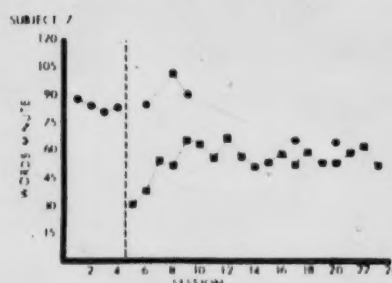
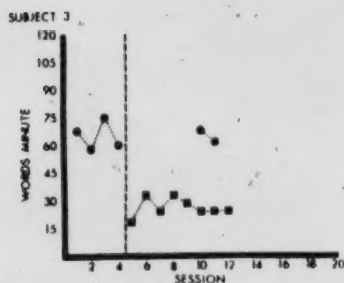
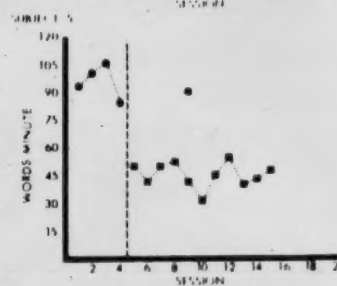
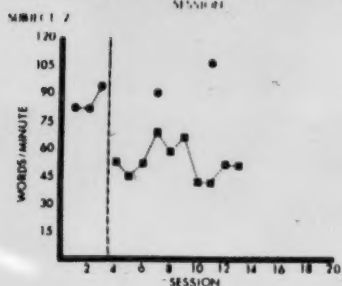
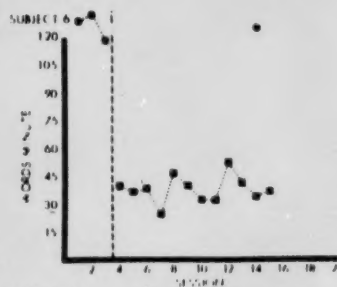
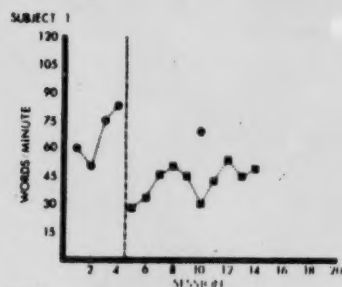
51

circles = conventional braille materials

squares = PBR reading materials

slashed line = the session during which the student obtained a score of 95 or better on the criterion-referenced proficiency test.

+Oral reading rates were calculated by dividing the total number of words read in five minutes by 5.



correct for one paper braille reading assessment session; squares represent the reading rate score in percent correct for one cassette braille assessment session. The vertical slashed line represents the session during which the student obtained a score of 95% or better on the criterion-referenced proficiency test.

Figure 16 is a tabular representation of each student's performance as measured by pre- and post-test scores. The conventional braille pre-test score for each subject was the third assessment score for paper braille obtained in all cases. The PBR pre-test scores was the first assessment score for cassette braille obtained in all cases. The first conventional post-test score represents the first probe session score for paper braille obtained in all cases. The PBR post-test scores represent the eighth cassette braille assessment score for all students. The second post-test scores for both conventional and PBR reading represent each student's final score in each reading condition. Consequently, as length of experience using the PBR is different for each student the statistical significance of the difference between conventional and PBR reading rates should be interpreted with caution.

As can be further seen in Figure 16, students exhibited a statistically significant difference ($p > .005$) in oral reading rates using paper braille and cassette braille on both pre-test and post-test measures; students consistently read faster with conventional paper braille. Students did not demonstrate, however, significant increases or decreases in reading rates across time as a function of reading condition; they maintained similar reading rates over time for both paper and cassette braille. This finding would seem

Figure 16

Tennessee: Child User Oral Reading Rates +

Subjects	Pre		Post ₁		Post ₂	
	Conv.	PBR	Conv.	PBR	Conv.	PBR
1	74.6	29	71.4	53.8	71.4	48.6
2	93.6	51.6	90	41.4	106.6	50.2
3	74.2	17.6	68	24.8	62.2	24.8
4	103.6	31.4	97.4	59.2	98.2	50.8
5	106.2	50.4	90.2	55.5	90.2	47.4
6	118.4	38.8	125.2	31.2	125.2	36.6
7	<u>80.2</u>	<u>30.6</u>	<u>84.6</u>	<u>66.6</u>	<u>66</u>	<u>48.0</u>
X=	92.97	35.62	X=89.54	47.5	X=88.5	43.7

Group	Mean	STD	T	DF
Pre _c	92.97	17.26	10.94*	6
Pre _p	35.62	12.21		
Post _c ¹	89.54	18.93	4.31*	6
Post _p ¹	47.5	15.4		
Conv. pre	92.97	17.26	1.20	6
Conv. post ₁	89.54	18.93		
PBR pre	35.62	12.21	1.74	6
PBR post ₁	47.5	15.40		
Post ₂ conv.	88.54	23.31	5.035*	6
Post ₂ PBR	43.77	9.63		

*p > .005

+Oral reading rates were calculated by dividing the total number of words read in five minutes by 5.

to suggest that although students' conventional reading rates were not negatively affected by their experience with the PBR, they did not appear to improve their reading rates using cassette braille after eight sessions (time range, approximately 8 weeks to 12 weeks) of use.

Figure 17 are graphs of the oral reading accuracy in both reading conditions for all seven subjects. As shown, all subjects demonstrated a high degree of accuracy in reading both cassette and paper braille materials. Reading accuracy was calculated as the percent of total words read correctly divided by the total words read.

Figure 18 charts the number of errors per minute as a function of reading mode and subject on pre-test measures of oral reading rate. As shown, subjects demonstrated a significantly greater number of errors reading cassette braille rather than paper braille on the pre-test measures; however, after the eighth session, subjects committed a similar number of errors in both reading conditions. Although subjects demonstrated insignificant differences in the number of errors committed on pre- and post-test measures of cassette braille reading, they significantly increased the frequency of errors as a function of time on the post-test measures of paper braille reading.

Figure 17
Graphs of Oral Reading Accuracy Rates
for Seven Child Users - Tennessee

57

circles = conventional braille materials

squares = PBR reading materials

slashed line = the session during which the student obtained a score of 95% or better on the criterion-referenced proficiency test.

*Oral reading accuracy rates were calculated by dividing the total number of words read correctly by the total number of words read and multiplying by 100.

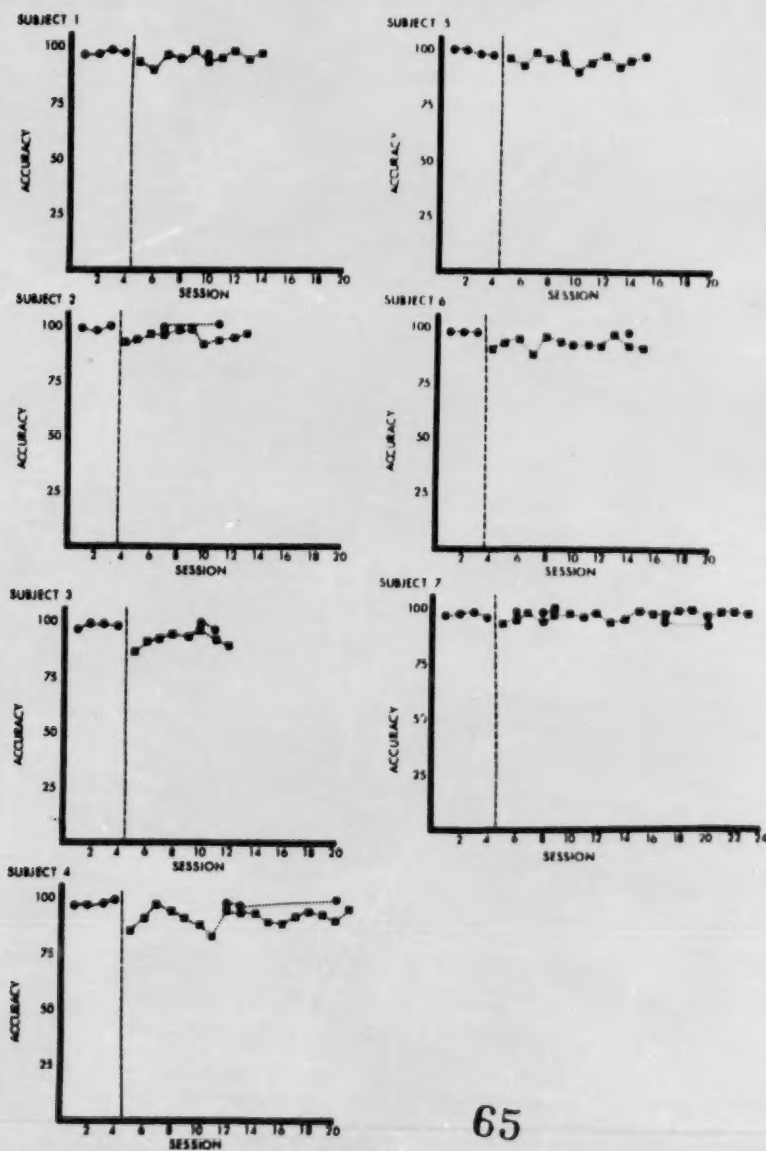


Figure 18

Tennessee: Child User Oral Reading Error Rates⁺

Subjects	Pre		Post ₁		Post ₂	
	Conv.	PBR	Conv.	PBR	Conv.	PBR
1	1.00	2.00	2.20	0.8	2.2	1.4
2	0.80	3.2	1.20	2.6	.4	1.6
3	1.6	2.4	1.8	2.8	2.8	2.8
4	2.8	4.4	3.0	2.2	3.8	4.4
5	1.4	1.8	2.6	1.5	2.6	1.2
6	2.6	4.0	3.0	2.2	3.0	3.5
7	<u>2.6</u>	<u>3.0</u>	<u>3.6</u>	<u>1.8</u>	<u>3.4</u>	<u>2.0</u>
	X= 1.82	2.97	X=2.48	1.98	X=2.6	2.4

Group	Mean	STD	T	DF
Pre conv.	1.82	.828	4.2*	6
Pre PBR	2.97	.982		
Post conv.	2.48	.81	1.08	6
Post PBR	1.98	.68		
Conv. pre	1.82	.828	3.79*	6
Conv. post	2.48	.815		
PBR pre	2.97	.98	2.92	6
PBR post	1.98	.68		
Post conv. _x	2.6	1.10	.47	6
Post PBR _x	2.4	1.19		

*p > .005

⁺Oral reading error rates were calculated by dividing the total number of errors committed in five minutes by 5.

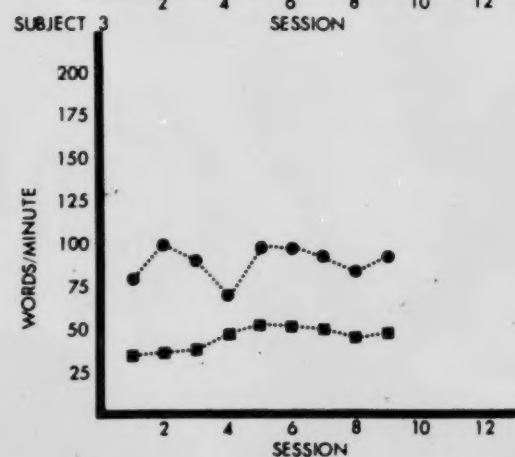
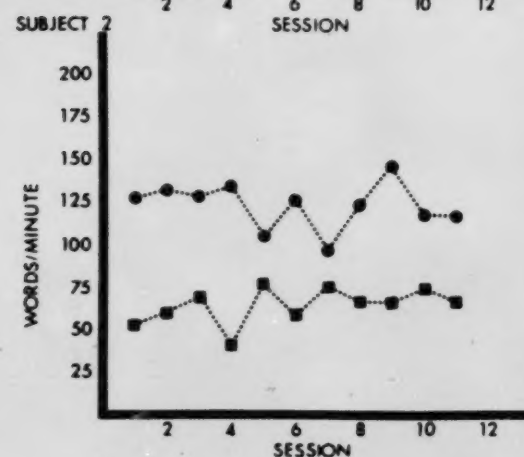
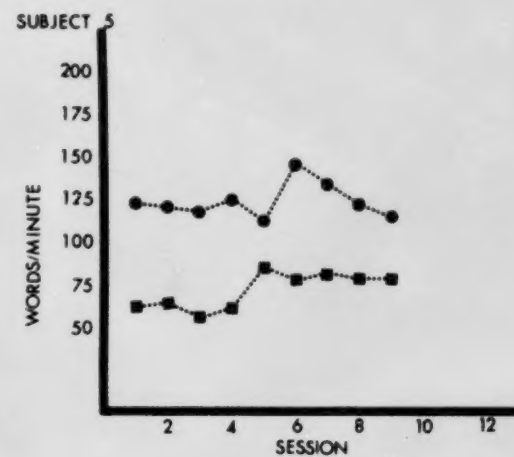
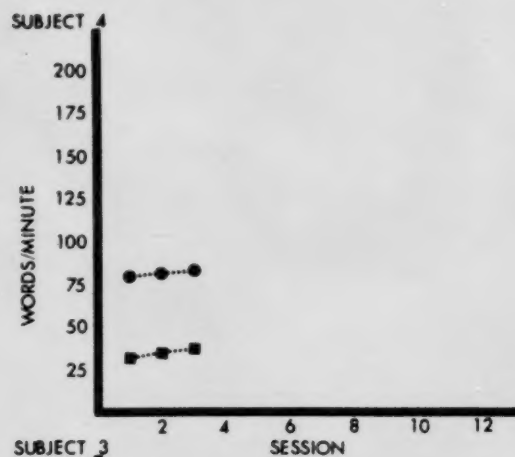
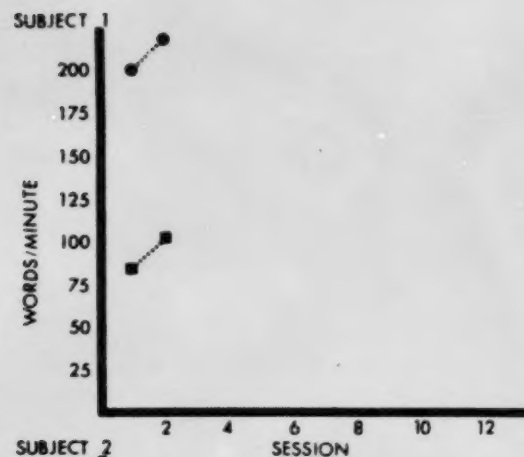
Figure
Graphs of Oral Reading Rates+
for Five Adult Users - Tennessee

circles = conventional braille materials

squares = PBR reading materials

slashed line = the session during which the student obtained a score of 95% or better on the criterion-referenced proficiency test.

+Oral reading rates were calculated by dividing the total number of words read in five minutes by 5.



IV. Method: Adults, Tennessee

Five braille reading undergraduate and graduate students at George Peabody College participated in data collection activities. These subjects required only one instructional session in order to be able to utilize the PBR. Therefore, each experimental session included a five minute assessment of both cassette and paper braille reading; the presentation of the two reading conditions was counter-balanced. Recordings of the sessions were transcribed and words per minute and errors per minute were calculated as previously described.

Reading Assessment Materials

The high school and adult level reading materials previously described and included in Appendix 8 were used with these subjects.

Results

Figure 19 are graphs of each subject's reading rates; circles represent conventional paper braille scores and squares represent cassette braille scores. As shown in these graphs, all subjects consistently read at faster rates when reading conventional braille. This is not surprising considering the large difference in length of time and experience between conventional reading versus cassette braille reading (approximately 10-15 years versus 2-6 months, respectively).

Figure 20 is a chart of pre- and post-test measures of oral reading rates in both conditions. As shown, subjects demonstrated significant differences in oral reading rates when using paper or cassette braille on both pre- and post-test measures of reading rate. Subjects did not demonstrate differences between pre- and post-test measures when reading paper braille materials; however, a significant improvement in reading rates using the PBR was seen

Figure 20

Tennessee: Adult User Oral Reading Rates +

Subjects	Pre		Post	
	Conv.	PBR	Conv.	PBR
1	198.6	82.8	217.6	102.8
2	126.6	52.6	116.0	66.4
3	79.4	33.4	88.8	45.7
4	77.6	31.2	84.5	36.8
5	<u>123.4</u>	<u>62.2</u>	<u>114.4</u>	<u>77.4</u>
	X=121.12	52.44	X=124.26	65.82

Group	Mean	STD	T	DF
Pre conv.	121.12	49.17	5.33**	4
Pre PBR	52.44	21.39		
Post conv.	124.26	54.12	4.09*	4
Post PBR	65.82	26.21		
Conv. pre	121.12	49.17	.554	4
Conv. post	124.26	54.12		
PBR pre	52.44	21.39	5.73**	4
PBR post	65.82	26.21		

** $p > .005$

+Oral reading rates were calculated by dividing the total number of words read in five minutes by 5.

Figure 21 is a chart of pre- and post-test measures of oral reading error rate with conventional paper braille and cassette braille. Because subjects demonstrated insignificant differences in error rate on all statistical comparisons, graphs of individual subject's error rates were not made. All subjects demonstrated similar accuracy in reading both paper and cassette braille.

Figure 21

Tennessee: Adult User Oral Reading Error Rates⁺

<u>Error</u>	<u>Pre</u>		<u>Post</u>	
	<u>Conv.</u>	<u>PBR</u>	<u>Conv.</u>	<u>PBR</u>
1	1	.6	.2	.8
2	1.2	2.6	1.6	.8
3	2.6	4.6	1.8	3.0
4	.2	1.8	.4	2.0
5	<u>1.4</u>	<u>3.6</u>	<u>4.4</u>	<u>1.0</u>
	X= 1.4	2.64	X=1.68	1.52

<u>Group</u>	<u>Mean</u>	<u>STD</u>	<u>T</u>	<u>DF</u>
Pre conv.	1.4	.707	2.68	4
Pre PBR	2.64	1.55		
Post conv.	1.68	1.67	.17	4
Post PBR	1.52	.96		
Conv. pre	1.4	.707	.391	4
Conv. post	1.68	1.67		
PBR pre	2.64	1.55	1.98	4
PBR post	1.52	.965		

⁺Oral reading error rates were calculated by dividing the total number of errors committed in five minutes by 5.

Summary

Child PBR users were found to read aloud an average of approximately 42 to 47 words per minute with the PBR at the end of their participation in this study as compared with an average of approximately 72-89 words per minute with conventional paper braille. Reading error rates and accuracy rates were not significantly different between the two conditions; the error rates were relatively low (range 1-8 errors per minute).

Adult PBR users were found to read aloud an average of approximately 52 and 65 words per minute with the PBR at the end of their participation in this study as compared with an average of approximately 85 to 124 words per minute with conventional paper braille materials. Again, reading error rates and accuracy rates were not significantly different between the two reading conditions.

The chart below summarizes the above data. The word per minute scores represent the range of the average number of words read by 15 children and 9 adults at the end of their participation in this study.

	PBR	Conventional
Adults N=9	52-65 wpm	85-124 wpm
Children N=15	42-47 wpm	72-89 wpm

Objective 4 Assess the braille writing function of the PBR.

Rationale: The braille keyboard on the PBR is identical in function to that of the Perkins Brailler. Writing braille on the PBR should therefore be quite similar to writing with the Perkins Brailler. The PBR does, however, have an editing feature. A user may edit the 120 characters that are in the buffer before the characters are transferred to the cassette. This feature of the PBR may prove quite beneficial to the user.

Writing braille with the PBR is similar to writing with the Perkins Brailler; the advantage of the PBR is that it is more silent, and it possesses editing capabilities. These advantages are balanced by the potential time factor involved in editing the braille text, and the lack of a hard copy. Comparing these advantages and disadvantages, and hopefully, discovering some means by which they can be eliminated, are the reasons that the braille writing functions of the PBR were being assessed. Therefore, the question addressed here was: Is there a difference in writing rate and writing-error rate as a function of time when writing with the PBR and the Perkins Brailler?

Method: Ohio, Children

Students were administered a pre-test of writing rate and writing accuracy using the PBR and the Perkins Brailler. When subjects had been trained and had had access to the PBR for the length of time in which they were involved in the project, they received a post-test of writing and accuracy rates using the PBR and the Perkins brailler. The pre- and post-tests consisted of selected passages of appropriate graded difficulty taken

from the Diagnostic Reading Scales by George D. Spache, published by McGraw-Hill, Inc., 1963, and from Tests of Academic Progress, published by Houghton Mifflin Company, 1971. (Appendix 9).

The tests were administered in the same manner for both the pre- and the post-testing. Each student sat in a quiet setting and was asked to write the passages as they were dictated to them by the graduate associates. The passages were written with first the Perkins Brailier and then the Portable Braille Recorder. Each indentation, word, and punctuation mark was given to the student as written on the print copy. They in turn were to write the braille counterpart. A stopwatch was used to record the time required to complete the test.

All tests were transcribed from the PBR onto the paper and then scored for the number of words written per minute and the number of errors committed per minute.

Results:

Figure 20 is a chart of the pre-and post-test writing rates for the eight children from the Ohio School for the Blind and from the Columbus Public Schools. As shown, these children performed significantly better ($p > .005$) on the pretest using the Perkins Brailier as compared with the PBR. However, on the post-test measures, there were insignificant differences between the two writing conditions. Subjects demonstrated a significant improvement in writing with the PBR over the duration of this study. All other comparisons yielded statistically insignificant differences.

Figure 23 is a chart of the writing error rates on pre-and post-test measures of writing rate using the PBR and the Perkins Brailier. As shown, all comparisons yielded statistically insignificant differences.

Subjects committed comparable numbers of errors in both writing conditions on both pre- and post-test measures.

Method: Tennessee, Children

Time limitations impeded the collection of writing data with the subjects at the Tennessee School for the Blind and the Nashville public schools; research and evaluation efforts concentrated on the braille reading objectives in this report. However, at the end of each subject's participation in data collection activities, subjects were asked to copy from a paper braille text to paper braille using a Perkins braille and to cassette braille using the PBR. Figure 24 represents the writing rate scores of seven subjects. Subjects did not demonstrate statistically significant differences in writing performance using either the Perkins braille or the PBR.

Figure 25 is a chart of the writing accuracy scores for these seven subjects on the writing rate measures. Subjects again did not demonstrate statistically significant differences in writing accuracy rates in the two writing conditions.

Figure 22

Ohio: Child User Writing Rates⁺

Subjects	<u>Pre</u>		<u>Post</u>	
	<u>Conv.</u>	<u>PBR</u>	<u>Conv.</u>	<u>PBR</u>
1	12.33	12.07	15.7	13.7
2	21.78	18.04	18.05	25.28
3	23.4	13.6	22.66	17.06
4	13.35	8.72	10.82	11.72
5	15.60	12.02	15.8	14.6
6	21.12	20.33	23.4	21.4
7	19.15	17.01	20.2	15.6
8	<u>15.08</u>	<u>8.44</u>	<u>17.5</u>	<u>13.8</u>
	$\bar{X}=17.72$	13.77	18.01	16.64

Group	Mean	STD	T	DF
Pre conv.	17.726	4.17	3.55**	7
Post PBR	13.778	4.33		
Post conv.	18.01	4.09	.9623	7
Post PBR	16.64	4.52		
Conv. pre	17.72	4.17	.328	7
Conv. post	18.01	4.09		
PBR pre	13.77	4.336	3.069*	7
PBR post	16.64	4.529		

*p > .01

**p > .005

⁺ Writing rates were calculated by dividing the total number of whole words written by five (minutes)

Figure 23

Ohio: Child User Writing Error Rates +

<u>Subjects</u>	<u>Pre</u>		<u>Post</u>	
	<u>Conv.</u>	<u>PBR</u>	<u>Conv.</u>	<u>PBR</u>
1	(---	1.85)	(1.58	---)++
2	(1.43	1.55)	(1.36	---
3	.96	1.28	.46	4.16
4	.79	.85	.48	1.56
5	1.6	1.44	2.20	2.33
6	1.99	2.11	1.19	3.02
7	2.01	1.96	2.33	3.02
8	(2.42	---	(3.37	3.67)
	$\bar{X}=1.46$ (1.47)	1.53 (1.52)	1.67 (1.33)	2.64 (2.44)

<u>Group</u>	<u>Mean</u>	<u>STD</u>	<u>T</u>	<u>DF</u>
Pre conv.	1.46	.51	1.019	5
Pre PBR	1.53	.459		
Post conv.	1.67	1.159	1.71	5
Post PBR	2.64	1.18		
Conv. pre	1.47	.57	.53	4
Conv. post	1.33	.90		
PBR pre	1.52	.51	1.49	4
PBR post	2.44	1.2		

+Writing error rates were calculated by dividing the total number of errors committed by five (minutes).

++Scores within parentheses were not used when calculating comparisons between groups with missing data.

Figure 24

Tennessee: Child User Writing Rates⁺

<u>Subjects</u>	<u>PBR</u>	<u>Conv.</u>
1	11	13.6
2	16	20.6
3	11.2	18
4	14	13.2
5	4.4	12.8
6	19.8	21.4
7	<u>13</u>	<u>13.6</u>
	$\bar{X}=12.77$	16.17

Group	Mean	STD	T	DF
Conv.	16.17	3.735	.447	6
PBR	12.77	4.77		

⁺ Writing rates were calculated by dividing the total number of whole words written by five (minutes).

Figure 25

Tennessee: Child User Writing Accuracy Rates⁺

<u>Subjects</u>	<u>PBR</u>	<u>Conv.</u>
1	87%	98%
2	93%	97
3	73	94
4	60	85
5	60	91
6	71	91.5
7	<u>74</u>	<u>93</u>
	$\bar{X}=74$	92.7

<u>Group</u>	<u>Mean</u>	<u>STD</u>	<u>T</u>	<u>DF</u>
Conv.	92.78	4.31	.931	6
PBR	74	12.46		

⁺Writing accuracy scores were calculated by dividing the total number of words brailled correctly by the total number of words brailled and multiplying by 100.

Method: Tennessee Adults

Five graduate and undergraduate students at George Peabody College participated in this portion of the evaluation. During each experimental session, subjects copied from a paper braille text using the Perkins Brailier and the PBR. The two writing conditions were presented in a counterbalanced fashion in five minute sessions. Word per minute and accuracy scores were calculated from transcriptions of the braille copy.

Writing Materials

High school and adult level passages were used for writing assessment purposes. All passages were hand transcribed on paper and were equivalent in overall length. Examples of these writing passages are included in Appendix 10.

Results

Figure 26 are graphs of Perkins and PBR writing rates for the five adult subjects. Circles represent the word per minute scores for writing with the Perkins Brailier and the squares represent the word per minute scores for writing with the PBR. Only one subject (Subject 2) demonstrated differences in writing rate between the Perkins and the PBR; all other subjects demonstrated similar writing rates using both machines.

Figure 27 is a chart of pre- and post-test writing rates for these subjects. The pre-test score represents the first writing assessment score and the post-test score represents the last writing assessment score for each subject. As shown, subjects exhibited no differences in writing rates as a function of writing condition (Perkins vs. PBR) or time. That is, subjects brailled at similar rates when using the Perkins or the PBR on both pre-test and post-test measures.

Figure 28 are graphs of the writing accuracy rates of these subjects on the pre- and post-test measures. As shown, most subjects demonstrated accuracy scores between 85% to 100%. Figure 29 is a chart of the pre- and post-test writing error rates and accuracy rates for these subjects. Subjects did not demonstrate statistical differences in performance either as a function of writing condition or of time.

Figure 26

Graph of Writing Rate+
for Five Adult Subjects

Circles = Perkins Braille Writer

Squares = Portable Braille Recorder

+Writing rates were calculated by dividing the total number of whole words written by five (minutes).

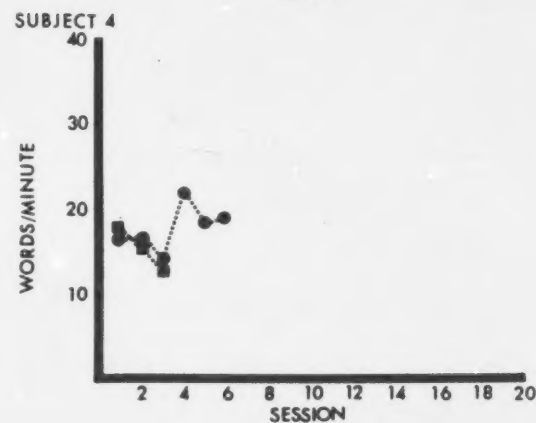
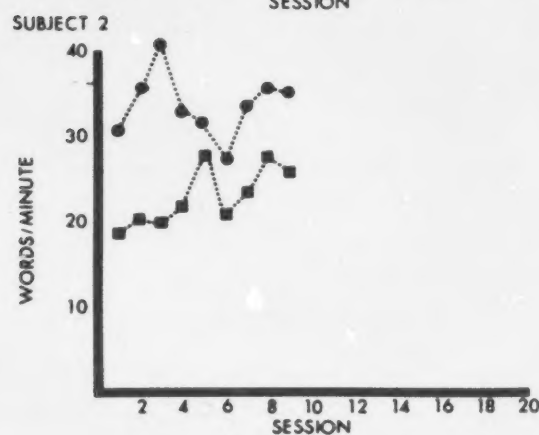
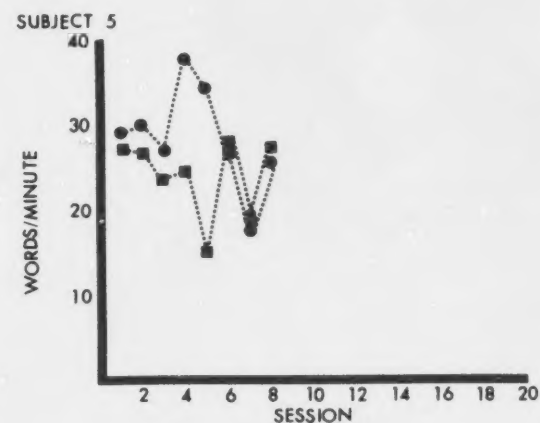
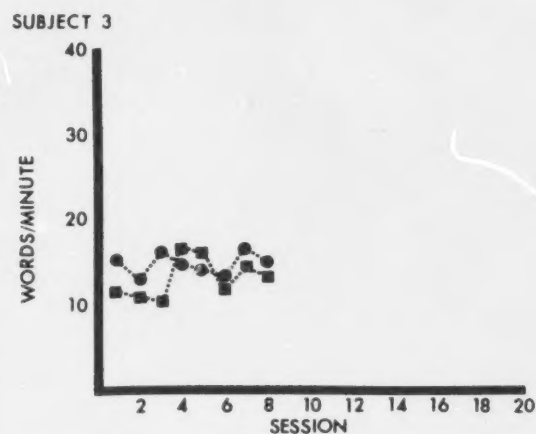
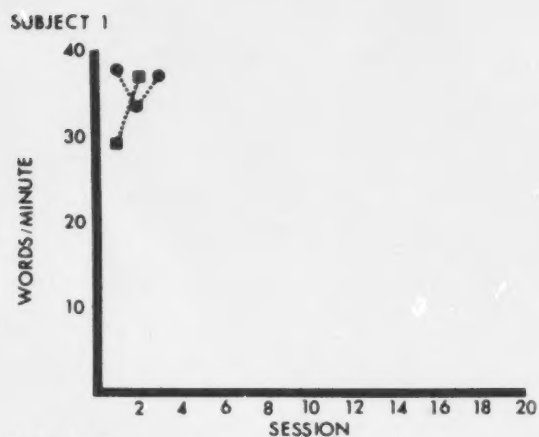


Figure 27

Tennessee; Adult Users Writing Rates+

<u>Subjects</u>	<u>Pre</u>		<u>Post</u>	
	<u>Conv.</u>	<u>PBR</u>	<u>Conv.</u>	<u>PBR</u>
1	38	29.6	35.4	37.6
2	30.6	19.4	26.2	20.4
3	14.8	11.4	15.2	16.8
4	16.6	18.8	14.8	13.2
5	<u>28.6</u>	<u>26.2</u>	<u>18.2</u>	<u>19.2</u>
	$\bar{X}=25.72$	21.08	21.96	21.44
	SD= 9.81	7.08	8.79	9.44

<u>Group</u>	<u>Mean</u>	<u>STD</u>	<u>T</u>	<u>DF</u>
Pre conv.	25.72	9.81	1.97	4
Pre PBR	21.08	7.08		
Post conv.	21.96	8.79	.3536	4
Post PBR	21.44	9.44		
Conv. pre	25.72	9.81	2.05	4
Conv. post	21.96	8.79		
PBR pre	21.08	7.08	.122	4
PBR post	21.44	9.44		

+Writing rates were calculated by dividing the total number of whole words written by five (minutes)

Figure 20
 Graphs for Writing Accuracy Rate+
 for Five Adult Subjects

Circles = Perkins Braille Writer

Squares = Portable Braille Recorder

+Writing accuracy scores were calculated by dividing the total number of words brailled correctly by the total number of words brailled and multiplying by 100.

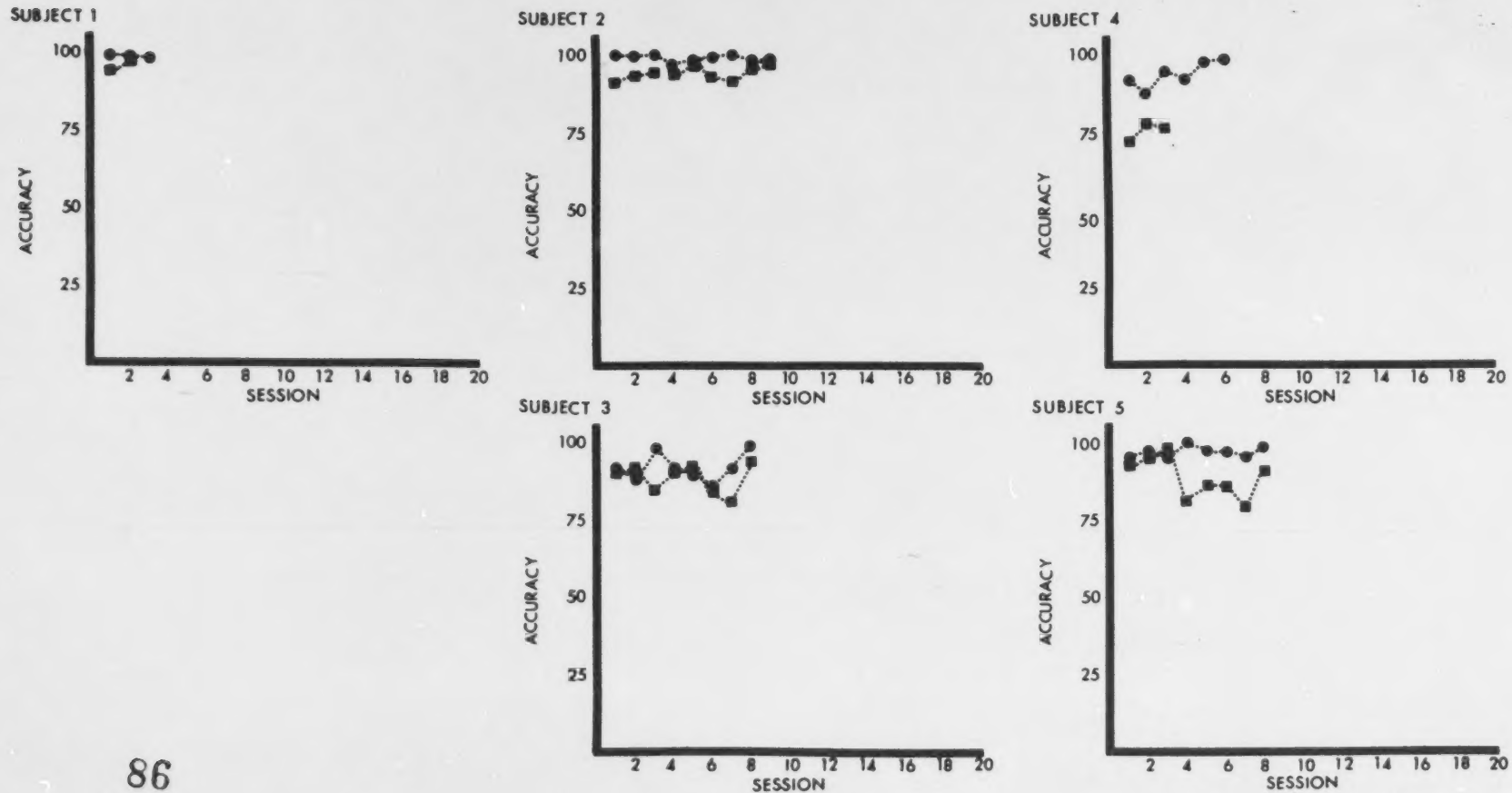


Figure 29

Tennessee: Adult Users Writing Error Rates⁺

		<u>Pre conv.</u>	<u>PBR</u>	<u>Post conv.</u>	<u>PBR</u>
Errors	1	.4/98%	1.4/95	.6/98	.4/99
	2	.2/99.3	1.8/90.7	.2/99.2	1.4/93.1
	3	1.2/91.8	1.2/89.4	1.6/89.4	1.2/92.8
	4	1.4/91	5.4/71	.8/94	3.0/77
	5	<u>1.2/95.8</u>	<u>2. /92.3</u>	<u>1.0/94.5</u>	<u>4.2/78.1</u>
		$\bar{X} = .88$	2.34	.84	2.89

Group	Mean	STD	T	DF
Pre conv.	.88	.54	2.17	4
Pre PBR	2.36	1.72		
Post conv.	.84	.517	1.739	4
Post PBR	2.04	1.53		
Conv. pre	.88	.54	.2324	4
Conv. post	.84	.517		
PBR pre	2.36	1.72	.426	4
PBR post	2.04	1.53		

⁺Writing error rates were calculated by dividing the total number of errors committed by five (minutes).

Objective 5: To identify patterns of use of the PBR, including reading styles, writing styles, and the way in which the PBR is used in daily activities of the subjects.

Rationale: The principal rationale supporting this objective is that the unique characteristics of the PBR will encourage a number of user patterns. Identifying those patterns that appear advantageous and isolating the factors that distinguish good and poor users of the PBR will enable guidelines to be developed for future users.

Method: Project staff had designed this objective to:

1. Identify good and poor braille readers.
2. Identify reading styles and patterns with PBR.
3. Identify writing styles and patterns with PBR.
4. Identify ways PBR is used in daily activities of subjects.

Information from logs, surveys, forms, interviews of participants, observational forms and super 8 movies was intended to be collected and analyzed. Data collection proceeded on schedule except for the movie filming, which was not accomplished due to time and logistics factors. Consequently, the use of super 8 movie equipment to permanently record patterns of PBR use was replaced by a non-instrumental behavioral observation technique.

The Reading Behavior Observation Form and the Factors Present in Oral Reading Session Form (See Appendix 11) were used by project staff to collect data on reading styles using the PBR during each assessment session. In as much as these observations were made during assessment/testing sessions, the data reflect the test-taking behaviors of the subjects and not necessarily the reading behavior of subjects in non-test situations.

Results:

Based on a compilation of data collected using the Reading Behavior Observation forms, see Figure 30, and informal observations, it was found that subjects readily adapted their reading styles to maximize their reading performance with the PBR regardless of whether they were good or poor braille readers. Although subjects generally had to read the PBR with their right index finger only, in a circular fashion, this factor did not affect their conventional braille reading rates or style. Subjects were judged to use a heavier finger pressure with the PBR than with conventional braille at the onset of the study; however, in time, the frequency of light finger pressure increased. Subjects were observed to scrub braille cells more often with the PBR than with conventional braille; however, in time this behavior decreased. Subjects were also judged to read the PBR less fluently than conventional braille; they stopped to reread words and had trouble with braille contractions. In time, however, these behaviors improved and were not significantly different from similar behaviors when reading conventional braille.

Generally, readers found reading with one hand with the remaining hand left idle most efficient. The hand used for reading completed the twelve cell display, brushed the touch control switch which changed the line, and then the hand used for reading returned to read the next twelve characters displayed. Readers found it necessary to take precautions in keeping the other fingers not used for reading from accidentally touching the touch control switch. Consequently, most readers held their reading hand in a fist with the reading finger extended.

READING RECOVERY OBSERVATION FORM: CHILDREN, 8-10

	Pre-test Observation (m)		Post-test Observation (m)	
	PM	CM	PM	CM
Posture: 1. Appropriate reading position, natural, relaxed, erect 2. Inappropriate reading position, slumped, tense, bent	1. 100%	1. 100%	1. 100%	1. PM 2. 40 N/A 175
Drillie Material: 1. Read on desk 2. Read on lap	1. 100%	1. 87.5% 2. 12.5%	1. 75% 2. 75%	1. 75% 2. 42.5 N/A 17.5%
Page Angle with Body: 1. Parallel 2. Arute on right 3. Arute on left	N/A 100%	1. 75% 2. 8.3% 3. 20.0%	1. 66.6% 2. 30.0% N/A 17.5%	1. 70.0% 2. 4.1% 3. 75%
Page Turnage: 1. Very efficient 2. Average 3. Awkward	N/A 100%	1. 66.6% 2. 8.3% N/A 16.6%	N/A 100%	1. 17.5% 2. 16.6% 3. 6.3% N/A 64.5%
Shifts to Page Position: 1. Frequent 2. Occasional 3. Never or seldom	N/A 100%	2. 4.1% 3. 95.8%	2. 12.5% 3. 79.1% N/A 82.2%	2. 4.1% 3. 79.1% N/A 8.2%
Handedness: 1. Uses right hand 2. Uses left hand 3. Uses both hands	1. 37.5% 2. 12.5% 3. 50%	1. 37.5% 2. 6.6% 3. 67.5%	1. 16.6% 2. 8.3% 3. 29.5% N/A 37.5%	1. 12.5% 2. 4.1% 3. 64.5% N/A 22.5%
4. Reads with one hand a. Right hand with left idle b. Right hand with left marking location of new line c. Left hand with right idle	4. 37.5% c. 8.3% N/A 54.2%	4. 12.5% b. 25% N/A 62.5%	4. 12.5% b. 8.3% N/A 79%	4. 25% c. 4.1% N/A 75%
5. Reads with two hands a. Keeps both hands together to complete line b. Right completes line, left moves to new line and reads few words c. Right completes line, left moves to new line and reads first half, hands meet briefly near middle of line	5. 29.1% b. 20.0% c. 4.1% N/A 49.0%	5. 29.1% b. 8.3% N/A 62.5%	5. 65.0% b. 12.5% N/A 84.1%	5. 33.3% b. 12.5% c. 8.3% N/A 65.0%
Drifts: 1. Retained 2. Regained	1. 95.8% 2. 4.1%	1. 100%	1. 91.6% 2. 8.3%	1. 87.5% 2. 4.1% N/A 12.5%
Reading Finger(s): 1. Index only 2. Index and second 3. Three or more fingers 4. Other fingers resting on reading line 5. Other fingers clamped	1. 83.3% 2. 8.3% 3. 12.5% 4. 16.6% 5. 64.6%	1. 75% 2. 12.5% 3. 25% 4. 16.6% 5. 29.0%	1. 83.3% 2. 12.5% 3. 12.5% N/A 4.1%	1. 87.5% 2. 12.5% 3. 12.5% N/A 4.1%
Finger Pressure: 1. Light 2. Heavy 3. Erratic	1. 62.5% 2. 25% 3. 12.5%	1. 87.5% 2. 12.5%	1. 95.8% 2. 4.1% N/A 4.1%	1. 87.5% 2. 4.1% N/A 8.3%
Sub (scure) Letters: 1. Often 2. Occasionally 3. Hardly ever	1. 20.0% 2. 41.6% 3. 33.3%	1. 16.6% 2. 50% 3. 33.3%	1. 8.3% 2. 84.1% 3. 13.3% N/A 4.1%	1. 12.5% 2. 33.3% 3. 54.1%
Retracting: 1. Frequent 2. Occasional 3. Never or seldom 4. Letters 5. One word 6. Phrase 7. Sentence or line	1. 16.6% 2. 54.1% 3. 29.1% 4. 16.6% 5. 41.6% 6. 16.6%	1. 12.5% 2. 50% 3. 33.3% 4. 16.6% 5. 25% 6. 16.6%	1. 12.5% 2. 42.5% 3. 20.0% 4. 12.5% 5. 25% 6. 4.1%	1. 12.5% 2. 50% 3. 37.5% 4. 12.5% 5. 25% 6. 4.1%
Loss of Place on Line: 1. Frequent 2. Occasional 3. Never	N/A 100%	3. 100%	1. 12.5% 2. 25.1% 3. 29.1% N/A 29.1%	1. 20.0% 2. 20.0% 3. 70.0% N/A 8.2%
Return Sweep to: 1. Efficient 2. Hesitant 3. Very slow	1. 91.6% 2. 8.3% 3. 4.1%	1. 83.3% 2. 12.5% 3. 4.1%	1. 83.3% 2. 4.1% N/A 12.5%	1. 95.8% 2. 4.1%
Loss of Place in Return Sweep: 1. Frequent 2. Occasional 3. Never	N/A 100%	1. 4.1%	1. 8.3% 2. 75% 3. 62.5% N/A 4.1%	1. 20.0% 2. 20.0% 3. 70.0% N/A 0.2%
Reading Accompanied with Silent Speech Movement (lips, tongue): 1. Often 2. Occasionally 3. Hardly ever 4. Never	1. 4.1% 2. 4.1% 3. 25% 4. 70.0%	1. 8.3% 2. 4.1% 3. 25% N/A 6.3%	1. 4.1% 2. 4.1% 3. 25% N/A 64.1%	1. 39.0% 2. 39.0% 3. 20.0% N/A 50%
General Evaluation: 1. Reads fluently and with comprehension 2. Reads haltingly 3. Word calling 4. Little comprehension	1. 45.0% 2. 54.1% 3. 16.6% 4. 12.5%	1. 87.5% 2. 12.5%	1. 58.3% 2. 37.5% N/A 4.1%	1. 87.5% 2. 37.5% N/A 8.2%
FACTORS PRESENT IN CHILD READING SITUATION				
1. The child was: a. uneasy b. at ease c. unconcerned	a. 16.6% b. 83.3% c. 8.3%	a. 8.3% b. 62.5% c. 8.3%	a. 16.6% b. 83.3% N/A 0.1%	a. 16.6% b. 95.8% N/A 8.1%
2. Motivation to do well was: a. high b. average c. low	a. 94.1% b. 45.8% c. 12.5%	a. 87.5% b. 12.5%	a. 41.6% b. 58.3% N/A 0.1%	a. 94.1% b. 62.5% N/A 43.8%
3. Quality of this performance was (as compared with usual performance, if known): a. very superior b. superior c. average d. below average e. very poor	c. 16.6% d. 8.3% N/A 79.1%	b. 20.0% c. 66.6% N/A 12.5%	b. 20.0% c. 41.6% d. 12.5% N/A 25%	a. 4.1% b. 37.5% c. 29.1% N/A 29.1%
4. The material appeared to be of: a. very high interest b. high interest c. average interest d. little interest	a. 8.3% b. 23.3% c. 50% d. 12.5%	a. 8.3% b. 62.5% c. 25% N/A 4.1%	b. 20.0% c. 70.8% d. 4.1% N/A 8.1%	a. 58.3% b. 29.1% c. 12.5% N/A 12.5%
5. The material seemed to be: a. very easy b. easy c. average d. difficult e. very difficult	b. 12.5% c. 84.6% d. 79.1% e. 4.1%	b. 45.8% c. 45.8% d. 8.3%	b. 37.5% c. 54.1% d. 8.3% N/A 8.3%	b. 58.3% c. 29.1% d. 8.3% N/A 8.3%
6. The child seemed to have most difficulty with: a. abbreviated words b. words with brittle constructions c. words largely in full spelling d. names e. punctuation f. other	f. 8.3% N/A 91.6%	a. 12.5% b. 58.3% c. 16.6% d. 20.0% e. 12.5%	b. 45.8% c. 12.5% d. 12.5% N/A 8.3%	b. 50% c. 8.3% d. 8.3% N/A 8.3%
7. The child read: a. in an even flow b. staccato and re-read words frequently c. made frequent retractions over the line he reads or larger part of it.	a. 33.3% b. 90% c. 8.3% N/A 8.3%	a. 79.1% b. 16.6%	a. 66.6% b. 29.1% N/A 4.1%	a. 79.1% b. 8.3% N/A 12.5%

Figure 30 (continued)

READING SESSION OBSERVATION FORM, ADULTS, Q10	Pre-test Observation (s=)		Interim Observation (s=)		Post Observation (s=)	
	PM	CM	PM	CM	PM	CM
Posture: 1. Appropriate reading position, relaxed, erect 2. Inappropriate reading position, slumped, hunched, bent	1. 83% 2. 17%	1. 83% 2. 17%	1. 100% 2. 100%	1. 100% 2. 100%	1. 100% 2. 100%	1. 100% 2. 100%
Breath Material: 1. Read on desk 2. Read on lap	1. 100% 2. 100%	1. 100% 2. 100%	1. 100% 2. 100%	1. 100% 2. 100%	1. 100% 2. 100%	1. 100% 2. 100%
Page Angle with Body: 1. Parallel 2. Acute on right 3. Acute on left	100% 2. 17% 3. 17%	1. 66% 2. 17% 3. 17%	1. 66% 2. 100% 3. 100%	1. 66% 2. 100% 3. 100%	1. 67% 2. 33% 3. 33%	1. 33% 2. 33% 3. 33%
Page Turning: 1. Very efficient 2. Average 3. Awkward	1. 66% 2. 17% 3. 17%	N/A N/A N/A	N/A N/A N/A	N/A N/A N/A	N/A N/A N/A	1. 67% N/A N/A
Shift to Page Position: 1. Frequent 2. Occasional 3. Never or seldom	N/A N/A 3. 100%	N/A N/A N/A	N/A N/A N/A	N/A N/A N/A	N/A N/A N/A	1. 67% N/A 3. 100%
Handedness: 1. Uses right hand 2. Uses left hand 3. Uses both hands	1. 17% 2. 17% 3. 66% N/A 33%	1. 17% 2. 17% 3. 66% N/A 33%	1. 100% 2. 100% 3. 100% N/A 100%	1. 66% 2. 66% 3. 66% N/A 66%	1. 67% 2. 33% 3. 33% N/A 33%	1. 33% 2. 33% 3. 33% N/A 33%
4. Reads with one hand a. Right hand with left idle b. Right hand with left marking location of new line c. Left hand with right idle	a. 33% b. 17% c. 50%	a. 17% b. 33% c. 50%	a. 66% b. 66% c. 66%	a. 66% b. 66% c. 66%	a. 67% b. 67% c. 67%	a. 33% b. 33% c. 33%
5. Reads with two hands a. Same both hands together to complete line b. Right completes line, left moves to new line and reads few words c. Right completes line, left moves to new line and reads first half, hands meet briefly near middle of line	a. 17% b. 17% c. 17% N/A 50%	a. 17% b. 50% c. 17% N/A 33%	N/A 100% N/A 100% N/A 100% N/A 100%	a. 33% b. 67% c. 33% N/A 67%	a. 33% b. 33% c. 33% N/A 33%	a. 33% b. 33% c. 33% N/A 33%
Words: 1. Reversed 2. Merged	1. 100% 2. 100%	1. 100% 2. 100%	1. 100% 2. 100%	1. 100% 2. 100%	1. 100% 2. 100%	1. 100% 2. 100%
Reading Finger(s): 1. Index only 2. Index and second 3. Three or more fingers 4. Other fingers resting on reading line 5. Other fingers clenched	1. 50% 2. 17% 3. 33% N/A 100%	1. 50% 2. 17% 3. 33% N/A 100%	1. 66% 2. 66% 3. 66% N/A 66%	1. 66% 2. 66% 3. 66% N/A 66%	1. 67% 2. 33% 3. 33% N/A 33%	1. 33% 2. 33% 3. 33% N/A 33%
Finger Pressure: 1. Light 2. Heavy 3. Erratic	1. 83% 2. 17% 3. 17%	1. 83% 2. 17% 3. 17%	1. 100% 2. 100% 3. 100%	1. 100% 2. 100% 3. 100%	1. 100% 2. 100% 3. 100%	1. 100% 2. 100% 3. 100%
Gaze (saccade) Letters: 1. Often 2. Occasionally 3. Hardly ever	1. 17% 2. 66% 3. 17%	1. 50% 2. 50% 3. 50%	1. 66% 2. 66% 3. 66%	1. 66% 2. 66% 3. 66%	1. 67% 2. 67% 3. 67%	1. 67% 2. 67% 3. 67%
Retractions: 1. Frequent 2. Occasional 3. Never or seldom 4. Letters 5. One word 6. Phrase 7. Sentence or line	1. 17% 2. 66% 3. 17% N/A 100%	1. 50% 2. 50% 3. 50% N/A 50%	1. 66% 2. 66% 3. 66% N/A 66%	1. 66% 2. 66% 3. 66% N/A 66%	1. 67% 2. 67% 3. 67% N/A 67%	1. 67% 2. 67% 3. 67% N/A 67%
Loss of Place on Line: 1. Frequent 2. Occasional 3. Never	1. 17% 2. 66% 3. 17%	1. 50% 2. 50% 3. 50%	1. 66% 2. 66% 3. 66%	1. 66% 2. 66% 3. 66%	1. 67% 2. 67% 3. 67%	1. 67% 2. 67% 3. 67%
Return Jump to: 1. Efficient 2. Hesitant 3. Very slow	1. 100% 2. 100% 3. 100%	1. 100% 2. 100% 3. 100%	1. 100% 2. 100% 3. 100%	1. 100% 2. 100% 3. 100%	1. 100% 2. 100% 3. 100%	1. 100% 2. 100% 3. 100%
Loss of Place in Return Jump: 1. Frequent 2. Occasional 3. Never	1. 17% 2. 66% 3. 17%	1. 50% 2. 50% 3. 50%	1. 66% 2. 66% 3. 66%	1. 66% 2. 66% 3. 66%	1. 67% 2. 67% 3. 67%	1. 67% 2. 67% 3. 67%
Reading Accompanied with Silent Speech Movement (lips, tongue): 1. Often 2. Occasionally 3. Hardly ever 4. Never	1. 17% 2. 66% 3. 17% N/A 100%	1. 50% 2. 50% 3. 50% N/A 50%	1. 66% 2. 66% 3. 66% N/A 66%	1. 66% 2. 66% 3. 66% N/A 66%	1. 67% 2. 67% 3. 67% N/A 67%	1. 67% 2. 67% 3. 67% N/A 67%
General Evaluation: 1. Reads fluently and with comprehension 2. Reads haltingly 3. Word calling 4. Lacks comprehension	1. 50% 2. 50% 3. 50% N/A 50%	1. 50% 2. 50% 3. 50% N/A 50%	1. 66% 2. 66% 3. 66% N/A 66%	1. 66% 2. 66% 3. 66% N/A 66%	1. 67% 2. 67% 3. 67% N/A 67%	1. 67% 2. 67% 3. 67% N/A 67%
FACTORS PRESENT IN ORAL READING SESSION						
1. The child was: a. uneasy b. at ease c. unconcerned	a. 33% b. 66% c. 100%	a. 33% b. 66% c. 100%	a. 33% b. 66% c. 100%	a. 33% b. 66% c. 100%	a. 33% b. 66% c. 100%	a. 33% b. 66% c. 100%
2. Motivation to do well was: a. high b. average c. low	a. 50% b. 50% c. 100%	a. 50% b. 50% c. 100%	a. 50% b. 50% c. 100%	a. 50% b. 50% c. 100%	a. 50% b. 50% c. 100%	a. 50% b. 50% c. 100%
3. Quality of this performance was (as compared with usual performance if known): a. very superior b. superior c. average d. below average e. very poor	a. 17% b. 17% c. 17% N/A 66%	a. 17% b. 17% c. 17% N/A 66%	a. 17% b. 17% c. 17% N/A 66%	a. 17% b. 17% c. 17% N/A 66%	a. 17% b. 17% c. 17% N/A 66%	a. 17% b. 17% c. 17% N/A 66%
4. The material appeared to be of: a. very high interest b. high interest c. average interest d. little interest e. no interest	a. 83% b. 83% c. 83% N/A 17%	a. 83% b. 83% c. 83% N/A 17%	a. 83% b. 83% c. 83% N/A 17%	a. 83% b. 83% c. 83% N/A 17%	a. 83% b. 83% c. 83% N/A 17%	a. 83% b. 83% c. 83% N/A 17%
5. The material seemed to be: a. very easy b. easy c. average d. difficult	a. 83% b. 83% c. 83% N/A 17%	a. 83% b. 83% c. 83% N/A 17%	a. 83% b. 83% c. 83% N/A 17%	a. 83% b. 83% c. 83% N/A 17%	a. 83% b. 83% c. 83% N/A 17%	a. 83% b. 83% c. 83% N/A 17%
6. The child seemed to have most difficulty with (check those that apply): a. abbreviated words b. words with breville contractions c. words tending to full spelling d. nouns e. punctuation f. other	a. 33% b. 33% c. 17% N/A 66%	a. 33% b. 33% c. 17% N/A 66%	a. 33% b. 33% c. 17% N/A 66%	a. 33% b. 33% c. 17% N/A 66%	a. 33% b. 33% c. 17% N/A 66%	a. 33% b. 33% c. 17% N/A 66%
7. The child read: a. in an even flow b. stopped and re-read words frequently c. made frequent retractions over the line he reads or larger part of it	a. 50% b. 33% c. 17% N/A 17%	a. 50% b. 33% c. 17% N/A 17%	a. 50% b. 33% c. 17% N/A 17%	a. 50% b. 33% c. 17% N/A 17%	a. 50% b. 33% c. 17% N/A 17%	a. 50% b. 33% c. 17% N/A 17%

Writing techniques with the PBR were quite similar to those of the Perkins Brailier. The major difference was the light touch used with the PBR as compared with the "pounding" necessary with the Perkins Brailier. Generally, participants were quite satisfied with, if not enthusiastic about, the responsiveness of the keyboard.

The transferring of the braille materials from the PBR's buffer memory to the cassette presented no problems. The tone which signaled the transfer was a very easy cue to follow.

In summary, reading was most efficient when using one index finger moving in a circular motion, across the display, up to the touch control switch and back to the beginning of the display. Generalization from the Perkins Brailier to the PBR was easily accomplished.

Using the PBR in Daily Activities

As most participants in the study were high school and college students, they used the PBR for taking notes in their classes. Although they encountered few problems in class with the PBR, and found using the PBR to be the most time efficient way to take notes, they expressed concern about not having their notes in paper form for later use. Most students who used the PBR extensively in class either transcribed their notes from PBR to paper, or only used the PBR in classes in which they would not want to save their notes for long periods.

The school-aged participants in Ohio did not use the PBR as often as would have been desired. They did not use the PBR as a substitute for the Perkin's Brailier or for conventional braille volumes due to the fact that teachers preferred to read and grade paper braille, and reading materials for the PBR were scarce. Teacher involvement with

the PBR was minimal due to interest and time constraints; consequently, reading practice, lessons, and other assignments were accomplished with conventional materials and extra, non-essential projects were attempted with the PBR. Transcription the teacher might do for her students would have to be done twice, once on paper and once on braille cassette, doubling his/her class preparation time. Consequently, teachers were not willing to devote the time necessary for this extra preparation. Although no formal data were obtained to assess teacher acceptance or non-acceptance of the PBR, it is clear from informal observation that teachers first reactions are enthusiastic; however, enthusiasm moderates rapidly when teachers realize that no paper counterpart of the braille material written on the PBR is available to be checked for accuracy or on which to indicate suggestions for improvement.

Objective 6: Develop the capability to efficiently produce braille reading materials on cassettes.

Rationale

In order to accomplish any of the proposed objectives, reading materials for use with the PBR had to be obtained. For the future acceptance of the PBR as a braille reading machine, it was necessary to be able to produce quality braille on cassette tape. If the production of braille cassettes is proven to be problematic, these problems will be identified.

Methods

The following outline describes the types of activities undertaken for the completion of this objective:

1. Identify volunteer braille transcribers in the Columbus metropolitan area; have materials brailled on paper and on cassette.
2. Explore the possibility of producing computer generated braille cassettes at the Ohio State Computer Center.
3. Identify volunteer braille transcribers in the Nashville, Tennessee metropolitan area.
4. Establish working relationships with computer personnel at Peabody and Vanderbilt Computer Centers.
5. Explore with Ohio State computer personnel the program they developed for converting APH tapes and their subsequent problems.
6. Develop a program to translate APH tapes to cassettes compatible with Peabody Computer hardware; obtain APH tapes of suitable reading material.

7. Implement the program developed to produce the first full-length book on cassette tape.
8. Explore the feasibility of duplicating master tapes for copies to distribute to APH, Library of Congress, ELINFA and users of PBR.
9. Examine the cassette tapes carefully to insure that all information and braille characters have been translated appropriately and establish the average rate of errors in the tape; explore the possibility of correcting errors in the cassette text using an appropriate computer program.
10. Prepare documents describing the APH tape-to-tape translation process; prepare a manuscript for publication, describing the APH tape-to-tape cassette tape translation process.

Results

1. Volunteer transcribers were contacted and commissioned to braille paper and cassette braille reading materials and testing materials. These braille cassette and paper materials were used throughout the two year study in Ohio and Tennessee.

2. Computer personnel at the Ohio State University Computer Center were contacted and John Snowden agreed to explore the feasibility of using the computer to convert braille on magtapes borrowed from the American Printing House. Appendix 12 contains the procedures Snowden used to successfully produce one APH title, Nothing Ever Happens Here, on cassette tape. Although this cassette could be copied using two PBR's connected together, standard tape duplicating equipment never did produce a useable copy of the master cassette tape.

3. Michelle Bourgeois contacted T. Hibbit, Director of the Nashville P I R A T E S , to investigate the possibility of obtaining brailled materials from that organization. The P I R A T E S are a group of inmates from the Tennessee State Men's Prison Facility, who serve the local Nashville area in providing braille materials for blind persons. Michelle Bourgeois met with two members of the P I K A T E S in October, demonstrated the PBR, and discussed the possibility of contracting with the P.I R A T E S for materials. Both men and Mr. Hibbit expressed their interest in cooperating in this endeavor. To date, we have not found it necessary to have materials brailled.

4. In October, 1978, James Hogge, Ph.D., Director of Peabody Computer Center, agreed to assist in exploring the feasibility of converting APH tapes to cassette tapes on campus. He contacted Vanderbilt Computer Center personnel and established a working agreement with them.

5. A meeting with John Snowden, Ohio State Computer Center, was held at Peabody in October. Mr. Snowden reviewed the program he developed and the problems he encountered in translating APH tapes. Using this information, Hogge subsequently wrote a translation program to be used with the Peabody Computer. David Palmer, Director of the Vanderbilt Computer Center, was contacted and the appropriate procedures were established to use the Vanderbilt computer for procedures unavailable at Peabody. The Vanderbilt Computer Center has been instrumental in converting 7-track APH tapes to the necessary 9-track tapes for use at Peabody.

Throughout the months of October and November, J. Hogge developed and revised the translation program in order to preserve the braille text and to insure that the resulting text would be efficiently presented on the PBR. This involved eliminating extraneous blank cells, page numbers, running titles and other extraneous information that is only relevant to the printed braille volume. In mid-November, J. Hogge successfully produced an entire text on cassettes (Intimate Behavior by Desmond Morris - 3 cassette sides).

6. The programs used to produce cassette braille tapes are included in Appendix 13. Also included are diagrams of the system set-up. Although these programs and diagrams produced useable cassette braille tapes using the Peabody computer system, they should only serve as guidelines to those who might wish to produce cassette braille tapes on other computer systems.

7. Using the tape translation and computer generated braille programs, the following titles have been successfully produced on cassette tapes:

1. Nothing Ever Happens Here (1 cassette side)
2. Psychics (2 cassette sides)
3. Intimate Behavior (3 cassette sides)

8. The Peabody Instructional Media Center has the capability of duplicating cassette tapes. Our first text, Intimate Behavior, was reproduced there. However, these tapes were read by several braille reading college students who reported that the quality of the tapes was so poor that the braille did not playback on the PBR. On certain tapes when braille would playback, other problems were encountered; namely, an extraneous nonsense character existed

before many braille contractions, and the apostrophe was missing in all possible instances. J. Hogge reworked the program, discovering the error accounting for the extraneous character. This problem has been eliminated. The lack of an apostrophe has been attributed to the braille-to-ASCII code conversion scheme.

Several different brands of tape duplicating equipment were used with equally poor results. Dr. Oleg Tretiakoff of ELINFA had promised to analyze the problems we encountered with the tape duplicating equipment; however, a report has not yet been forthcoming. We suspect that the information on the master tape is not being reproduced entirely, and therefore, the PBR does not recognize the recorded signals as braille. An electronics engineer would need to use an oscilloscope to test the signals being recorded to insure that the PBR is receiving a useable signal. In the meantime, tapes can be duplicated by interfacing two Digicassettes together and by transferring from a master cassette to a blank tape. However, this process is very time consuming.

Advisory Committee and Consultants

Advice and consultation was obtained throughout this project. However, the advisory committee was not convened due to the move from Ohio to Tennessee and the difficulty convening such a large group of people at a mutually acceptable time and place.

Nevertheless, phone conversations with many of the consultants served the purposes stated in the original grant. Also, informal meetings with various professionals and teachers including Tim Cranmer of the Kentucky Commission for the Blind and E. Foulke of The University of Louisville at national conventions and other meetings were held during which the evaluation of the PBR was discussed. Carson Nolan, American Printing House for the Blind, visited Peabody College in November, 1978, and his advice was sought concerning the evaluation of data collected and the feasibility of producing computer-generated braille cassettes. H. Savage of the Peabody Media Center was instrumental in the production and reproduction of braille cassettes.

On September 26 and 27, Susan Spungin of the American Foundation for the Blind and Fred Sinclair of the California Clearinghouse Depository for Handicapped Students met with project staff to discuss the findings of this study.

A telephone conference was held on September 27 in order to gain input and advice from other professionals who had used the PBR in employment and educational settings. The conference call included:

Lawrence Scadden - Smith Kettlewell Institute of Visual Sciences,
San Francisco, CA

Bill Kalenius - Clover Park School District, Tacoma, WA

John Taylor - Iowa Commission for the Blind

Norma Kreizer - New Jersey Commission for the Blind

Tim Cranmer - Kentucky Commission for the Blind

Fred Sinclair - Clearinghouse Depository for Handicapped
Students, Sacramento, CA

Susan Spungin - American Foundation for the Blind

S. C. Ashcroft - Professor, George Peabody College

M. Bourgeois - Research Assistant, George Peabody College.

An annotated transcript of the conference is included in

Appendix 14.

Summary of Findings

1. Child and adult users (subjects) were found to adapt readily to reading with the Portable Braille Recorder; however, there were significant differences in rates of oral reading with the PBR and conventional braille materials. Under test conditions, subjects (both child and adult and both good and poorer readers) read approximately 50% fewer words per minute with the Portable Braille Recorder than with conventional braille materials. There were no significant differences, however, in oral reading error rates using conventional or cassette braille materials.

2. Experience with the PBR did not appear to affect conventional braille reading ability either adversely or favorably.

3. Subjects were found to adapt their reading style to the unique features of the 12-cell reading display; they generally read the display using their right index finger only in a "circular" or "rotating" fashion.

4. Subjects readily accepted the differences in writing using the PBR and were generally enthusiastic about the "light touch" of the PBR as compared with the heavier touch necessary with the Perkins Brailier.

5. Subjects were found to adapt quickly to writing with the PBR. No statistically significant differences in writing rate or writing error rate were demonstrated in assessments of writing using the PBR and the Perkins Brailier.

6. The PBR was found to be more appealing to college students than to either high school students, to elementary school children, or to blind adults because of its use as a notetaking device. Most participants in the research program preferred to continue to read conventional braille volumes.

7. In general, participants were more satisfied with the PBR than they were dissatisfied; they liked using the PBR for notetaking in classes; they enjoyed the PBR's quietness, small size, weight, portability, and the correcting feature. The 12-cell reading display, the touch control switch, and the gravity control feature were agreed to be disadvantages of the PBR.

8. The PBR was found to be reliably maintainable with proper usage. Battery-related malfunctions (frequently due to over-charging or under-charging) accounted for most of the equipment failures; broken pins necessitated frequent repairs and return to ELINFA.

9. Service and repair time at the supplier's Washington office was often lengthy (4-6 weeks), and transportation by Federal Express (required by the supplier) was expensive.

10. Computer generated braille cassettes were produced using APH computer tapes; however, standard tape duplicating equipment did not make useable copies of the master tapes.

Future Research

Because of the slower reading rates using the PBR, the following questions have been raised:

1. Would participants be able to increase their reading rates with the PBR if training materials emphasizing a 12-cell reading line and utilizing the cloze technique were used?

Possibly the format of the material (12 cells per line) and the fact that words are broken at the ends of lines without regard to syllabication rules causes readers to read slower than usual. The cloze technique was designed to improve linguistic prediction skills for reading; students who could predict the form or function of a word from reading part of it might be able to increase their reading rates using the PBR.

2. Would participants be able to increase their reading rates with the PBR if the reading line was expanded to 20 cells or more? to 2 lines of 20 cells?

3. Would subjects be able to increase their reading rates with the PBR if the touch control switch was on the right versus the left side of the display? if the touch control switch was a pushbutton?

4. Would subjects be able to increase their reading rates with the PBR if only entire words and contractions were displayed for reading as opposed to parts of words?

5. Would it make a difference to reading rates if subjects could reread portions of the text not within the current buffer memory capacity?

Products:

1. Digicassette Operating Manual (Appendix 18)
2. Master Cassette Braille Tapes
 - a. Nothing Ever Happens Here
 - b. Intimate Behavior
 - c. Psychics
3. Manuscript: Based on Conference Call, October 26, 1979. Submitted to Journal of Visual Impairment and Blindness, "Discussion: Experiences with ELINFA's Digicassette in Research, Educational, and Employment Settings." (Appendix 14)
4. Presentation, AEVH Conference, Nashville, TN, June 16, 1979. "Evaluation Research Report: The Digicassette Braille Recorder." (Appendix 15)
5. Presentation: Association for Special Education Technology Conference, New Orleans, LA, March 4-9, 1979, "Recent Technological Developments for the Visually Impaired: State of the Art." Manuscript sent to Journal of Special Education Technology. (Appendix 16)
6. Presentation: Council for Exceptional Children, Dallas, Texas, April 24-28, 1979. "Paperless braille reading: A preliminary research report." Resources in Education, Published in ERIC Reports, ED171078, October, 1979. (Appendix 17)
7. Two computer programs for generating braille on cassette using the computer. (Appendix 13)

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